HONOURS, OR THIRD YEAR

COTTON SPINNING

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COTTON SPINNING

(*HONOURS, OR THIRD YEAR*)

BY

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ON DRAWFRAMES AND FLYFRAMES" ("SELF-ACTOR MULE," VOL. I.,
"MULE-SPINNING," VOL. II.), ETC.

BEING A COMPANION VOLUME TO "FIRST YEAR
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SECOND YEAR COTTON SPINNING"

WITH SEVENTY-FIVE ILLUSTRATIONS

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PREFACE.

SINCE the revision and extension of the scheme of the cotton spinning examinations of the City Guilds of London Institute, some four years ago, there has been greatly felt the need of a book dealing succinctly and definitely with the subjects comprised in the syllabus of the honours grade. Many times it has been pointed out to the author that no one book did cover this syllabus.

The first aim of the present work is to meet the requirements of the honours syllabus, and to more or less cover, as far as space has permitted, practically the whole of the subjects specified therein.

It must not, however, be imagined for a moment that this treatise is intended only for students in honours cotton spinning. On the contrary, it is hoped and believed that students actually attending classes will only form a comparatively small section of the readers.

It must be remembered that the present syllabus of the honours grade of the City Guilds has been expressly designed and passed by a selected committee of experts, with a view to meeting the requirements of masters, managers, foremen, salesmen and any others who already hold, or are hoping to hold, more or less responsible positions in connection with our great cotton spinning industry.

Any work, therefore, which expressly aims at fulfilling the requirements of this syllabus must necessarily appeal to all such individuals, and tend to be of more or less service to them.

To appreciate fully what is meant by these remarks, reference should be made to the honours syllabus as reprinted at the commencement of this work.

It will be seen that it comprises such subjects as the selection and commerce of cottons and cotton yarns; the practical manipulation of all the machinery contained in a fully-equipped coarse, medium or fine cotton spinning concern, as well as that of a cotton doubling mill; also mill planning; waste spinning; wages and fire prevention.

Speaking, for instance, with reference to reeling, doubling, thread making, etc., there is at the present time often an inquiry for a book dealing especially with these subjects. As they come well within the scope of the present honours syllabus, they are here dealt with somewhat fully.

In like manner, there has been latterly a good deal of interest manifested in cotton waste spinning, and a considerable amount of information on this subject will be found in this treatise.

Those familiar with the present author's more exhaustive treatises on special machines and processes of cotton spinning will well understand that he makes no pretence of having fully exhausted in this treatise the subjects that are more or less treated upon. Rather has it been his special aim to provide a comprehensive treatise covering the whole of the subjects specified in the honours syllabus.

Sufficient has now been said to fully indicate the scope and aim of this work, and it remains for the reader to judge whether the objects aimed at have been attained to the extent indicated above.

It may be added that with this volume also the grateful thanks of the author are due to the gentlemen and firms specified in the first volume. It may also be added to this preface that within the last two or three months an important Committee has been formed, composed of members of the County Council of Lancashire and representatives of Technical schools, a principal duty of this Committee being the consideration of how best to promote the study of spinning and weaving, by bringing the Examination syllabuses to still greater perfection and by any other suitable means.

THOMAS THORNLEY.

BOLTON, *August*, 1901.

DIRECTOR

[*Below is reproduced the Official Syllabus of the City and Guilds of London Institute for the Third Year's Course in Cotton Spinning.*]

HONOURS GRADE.

1. The character and quantity of waste produced at each stage in the preparation and spinning of cotton and its utilisation; the preparation of waste for spinning; spinning waste; the machinery used for this purpose; the character of the yarns produced, and the purposes for which they are suitable.

2. The production of doubled yarns; the machinery used; the preparation of yarn for doubling; the characteristics of each variety; the modes of utilising doubled yarn for different purposes, and the machinery employed therein; thread manufacture.

3. The terms and conditions on which raw cotton is bought; the method of selecting it when purchasing; the defects usually existing, and their effect upon the value; tests for moisture and the permissible limit.

4. The various uses to which cotton yarn is put; the characteristics required for each purpose; the methods of making up yarns for various markets; reeling and bundling machinery.

5. The methods of testing cotton yarns for strength, elasticity, twist and moisture; defects in yarn and their remedy; the conditioning of yarn; the terms and conditions of sale.

6. The manipulation of the cotton by the various machines; the defects occurring during work and the method of correcting them; the adjustment of the parts of each machine for

ordinary and special work; the necessary changes in the construction of the various machines for different kinds of work; the steps necessary to keep machines in good working order.

7. The construction and planning of spinning and doubling mills; the arrangement and selection of machinery for economical production; schemes of drafts, speeds and productions for various counts; the methods of lighting, heating, humidifying, ventilating and fire protecting; the arrangement of motive power and power transmission machinery.

8. Costs of production; wages; labour charges; insurance and other charges.

Full Technological Certificate.—A certificate will be granted on the results of the ordinary and honours grade examinations. For the full technological certificate in honours, the candidate must have passed the three examinations, and if not otherwise qualified must also have passed the Science and Art Department examinations—in the elementary stage at least—in geometrical as well as in freehand or model drawing, and also in two of the following subjects:—

Machine Construction.
Mathematics.
Theoretical Mechanics.
Applied Mechanics.

The certificate of the Lancashire and Cheshire Union for the preliminary examination in cotton spinning will be accepted by the institute in lieu of certificates in the above subjects.

[*Below are reprinted the two latest Examination Papers in the Honours, or Third Year's Stage.*]

CITY AND GUILDS OF LONDON INSTITUTE.

EXAMINATIONS DEPARTMENT.

TECHNOLOGICAL EXAMINATIONS, 1900

COTTON SPINNING.

HONOURS GRADE.—THIRD YEAR'S COURSE.

Tuesday, 1st May, 7 to 10

INSTRUCTIONS.

The number of the question must be placed before the answer in the worked paper.

Not more than twelve questions to be answered

The maximum number of marks obtainable is affixed to e ach question.

Answers should be illustrated, as far as possible, with clear sketches.

Three hours allowed for this paper

---

1. Describe the methods of preparing the various kinds of waste for re-spinning How are they prepared for carding, how treated and delivered by the cards? Is it possible to draw waste yarns? If so, to what extent, and where is it affected? (25 marks.)

2. For what purposes are waste yarns employed? For what kind of fabrics are they most useful, and why? (22.)

3. How many times, in your opinion, should yarn be twisted to produce six-fold thread? In what direction should the twist be introduced at each stage, and why? What are the number of turns per inch to be given to the thread at each stage, selecting any counts you like? (23.)

4. Describe the operation of twining. What are the advantages obtained, if any, over other systems of doubling when adopted for the production of doubled warps? How

does the machine compare as to amount of production with other machines? (25.)

5. You are supposed to be buying cotton for a mill spinning warp and weft counts 40's to 50's. The twist yarn must be strong and wiry, and the weft moderately soft. What kinds of cotton would you buy? What qualities would determine your selection, and how would you fix the price? Assume that colour is not of much importance. (23.)

6. A good deal of yarn is now being used for "mercerising". State (*a*) what kinds of cotton are best, (*b*) how they should be prepared and spun, (*c*) how should they be twisted. Reasons for your answers must be given. (24.)

7. If, in examining yarn, you discover soft places at intervals, to what would you attribute, and how remedy, them? An ample answer is required. (25.)

8. It is necessary to cleanse a scutching machine periodically. Name the parts which require cleaning, those which need most attention, and describe fully how and in what order you would proceed to clean them. If you were scutching low-middling American cotton, how often do you think you would need to thoroughly clean? (26.)

9. If, having charge of revolving flat carding machines, you found some of the webs with cloudy or bare places, to what causes would you attribute, and how would you remedy, either fault? (25.)

10. The slivers from a finishing drawing frame are found to be very uneven in weight at irregular intervals. What, in your opinion, is the reason for this, and how can it best be prevented? What happens if the cotton used is uneven in length? (24.)

11. Describe the construction of any differential motion of a roving frame with which you are acquainted. Say what would be the practical effect if the strain on the cone strap was so excessive as to cause it (*a*) to slip, or (*b*) not to advance when the traverse was changed. If you know of any means by which either of these faults can be prevented, describe it. (25.)

12. You are watching the working of a mule, and notice that when the carriage is (*a*) running out, or (*b*) running in, the spinning or winding is bad. Detail the faults that most frequently occur at either stage and their causes. A short, but complete, answer is required. (28.)

13. Say fully what differences there should be in the constructive details of drawing and roving frames used respectively for the preparation of 28's from good Broach cotton, and 150's combed yarn from Egyptian cotton. (25.)

14. Say what you know about the procedure necessary to keep carding engines in good working order. How often would you strip, grind and generally overhaul them if you were carding (*a*) good middling American, (*b*) brown Egyptian cotton? If, in grinding, you found the points very dull, how would you proceed? (25.)

15. Give a scheme of drafts for a mill to produce (*a*) 20's hosiery yarn, (*b*) 50's weft, (*c*) 100's combed Sea Island. You must state what weight of lap you begin with at the card. (27.)

16. Suppose that you had a free hand in the erection of a mill spinning a wide range of counts, say from 20's to 50's, two-thirds of the production being from 26's to 32's, what kind of machines would you select, and how would you arrange as to lifts of bobbins and other details? You can assume any total output you like. (25.)

17. What should be the principle upon which a spinning mill is lighted? Where is it necessary to have the light in the various stages, and what arrangement would you advise to give the best effect by day and night respectively (22.)

HONOURS GRADE.- THIRD YEAR'S COURSE.

Tuesday, 30th April, 7 to 10, 1901.

INSTRUCTIONS AS ABOVE GIVEN.

1. State in lb. the amount of waste made weekly in a mill producing 40,000 lb. net weight of yarn from 30's to 40's. At what points is it made, and of what character at each point? What kind of cotton would you use, and, crediting the value of the waste, what would it cost per lb. in the yarn? (23 marks.)

2. Describe any machine used for the purpose of breaking up hard waste, and say what the action on the cotton is, and in what condition it is delivered. (24.)

3. What are the chief differences between lace yarns, sewing

thread and doubled warps? What are the distinctive essential qualities of each, and why are they essential? (23.)

4. Describe fully the method of treating sewing thread after it is cabled, in order to prepare it for sale, either soft or glace. (24.)

5. Assume that you are purchasing cotton for a good quality medium count of warp yarn. Describe in full how you would proceed to judge the samples submitted to you. State what grade of cotton you would select, and, in the event of the cotton being delivered to you excessively moist, how you would determine the allowance to be made (24.)

6. Describe the process of reeling. How and in what lengths are the hanks wound for delivery (*a*) in this country, (*b*) in France, (*c*) for re-winding, (*d*) for bleaching? Say how the hanks are tied. (25.)

7. Is it possible to ascertain the twist in single yarns by any machine? If not, how would you most accurately ascertain it? What effect has twist upon the elasticity of yarn? In yarn intended for the pile threads of velveteens is strength or elasticity most important? (24.)

8. What are the terms and conditions on which cotton yarns are sold in Manchester, Bradford, Glasgow and Nottingham respectively, either with or without an agent? (23.)

9. What are the chief causes of unnecessary loss or damage to the cotton in the cleaning process (*a*) in the dust trunk, (*b*) in the opener, (*c*) in the scutcher? What is the character of the damage at each stage, and how would you prevent it? (26.)

10. Assume that you have had just completely overhauled, re-clothed and ground a revolving flat carding machine. How would you proceed to adjust the various working parts, and in what order? What precautions would you take before again commencing work? (27.)

11. You are watching the operation of a combing machine, and you notice that the sliver as delivered is cloudy or curled. To what causes would you attribute these defects, and how would you remedy them? (25.)

12. Detail the differences in the construction and operation of two mules, the one intended to spin 100's twist and the other 40's weft? A full answer is required. (25.)

13. How would you proceed to generally overhaul a mule?

What parts require the greatest attention or the most frequent adjustment? (25.)

14. If, on examining mule cops, either from the same or different mules, you found some of the cops badly wound or snarly, how would you proceed to discover the cause in either case? How is the defect most likely to arise? (25.)

15. What drafts would you use to spin (*a*) 24's ring twist from a ·15-hank sliver of Indian cotton, omitting the intermediate frame, (*b*) 40's weft from a ·16-hank sliver good middling American, (*c*) 100's twist from a ·19-hank sliver from Egyptian cotton, with and without a jack frame? (27.)

16. Describe and sketch the arrangement of spinning machines in a mill producing from 30's to 40's yarn two-thirds twist, (*a*) on mules, (*b*) on ring frames. Say (1) the number of spindles and gauge of machines, (2) if any difference in the arrangement of the line shafts is necessary in the two cases, (3) if any variation would be needed in the number or size of the preparatory machines. (26.)

17. Assume that you have 35,000 ring spindles producing 11 oz. per week each of 40's yarn. What number of preparing machines would you want, at what speed would you run the spindles, and what production would you expect to get from each? (24.)

18. State in detail the labour charges for preparing and spinning either 32's, 60's or 100's twist. (22.)

DIRECTOR OF INDUSTRIES.

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CHAPTER I.

COTTON.

Q. Name the chief cotton markets of the world in which the raw material is sold to the trade, and say what sections of the trade are supplied by each.

A. Liverpool is by far the most important cotton market of the world, and supplies by far the larger proportion of the English cotton mills, as well as many bales for consumption on the continent.

Manchester. -Owing to the construction of the Ship Canal and the efforts of many persons interested, there is now a large and ever-increasing trade in raw cotton done at Manchester.

Havre, on the river Seine, in France, is probably the principal cotton market for that country.

Bremen, one of the three free towns in North Germany, is the principal market for raw cotton in Germany.

Amsterdam serves for Holland.

Bombay is the principal cotton market in India.

New York is the principal cotton market for America, although considerable business is done in such places as New Orleans, Houston, Galveston, Charleston, etc.

Alexandria is the principal market for cotton in Egypt.

Q. How and through what agency is cotton bought in Liverpool? Describe the functions of buying and selling brokers, and their respective duties.

A. Usually when the representative of a spinning firm goes to Liverpool to buy cotton he acts through the agency and with the aid of a buying broker.

A *buying broker* may be stated to be a spinner's agent to assist him in his purchases, while a *selling broker* may be said to be a cotton merchant's agent to aid him in selling his cotton.

Both kinds of brokers receive one half per cent. commission or brokerage on all business done, the cotton merchant paying the selling broker and the spinner paying the buying broker.

Occasionally a person combines in himself the offices of both buying and selling brokers in order to receive "double brokerage," but this practice is not to be commended.

The buying broker not only assists the spinner when he goes to Liverpool, but sends information to the mills as to the state of the market, and attends to the proper delivery, marking and weighing of the bales. The payment for the cotton is made from spinner to the buying broker, who forwards the money to the selling broker and cotton merchant.

The spinner makes his claims for falsely packed cotton through his buying broker.

When a spinner goes to Liverpool he visits the office of his broker, and examines samples which may have been sent there from several selling brokers.

Q. 1899. What are the chief defects in cotton as it arrives in England? What effect has each upon its value? What is meant when cotton is described as wasty? How would you make allowances in valuing for such defects as irregular staple, dirtiness and excessive moisture?

A. The chief defects may be summarised as follows: Nep, unripe fibres, broken leaf, short and broken fibre, sand and mineral matter, moisture.

The effect of each one of these defects is to reduce the value of the cotton in proportion to the extent of which it is present. When cotton is "wasty" the weight of yarn produced from a given weight of cotton is much less than it should be on account of the loss in waste being too great. If we choose to buy cotton that was of irregular staple, dirty and excessively damp, it would be essential that the price per pound be sufficiently low as to compensate for the inevitable loss on working, or for the lessened price per lb. obtainable for the yarn.

At times cotton has been heavily charged with moisture, and this has led to the adoption in some cases of ovens for testing the amount of moisture from a small quantity of cotton in about one and a half hours. Such an oven is shown in Fig. 1.

Q. 1901. Assuming that you are purchasing cotton for a good quality medium count of warp yarn, describe in full how you would proceed to judge the samples submitted to you. State what grade of cotton you would select, and in the event of the cotton being delivered to you excessively moist, how would you determine the allowance to be made.

A. For a good quality of medium quality of warp yarn, we might select good middling Orleans cotton. In judging the cotton, the intending purchaser examines sometimes a very large number of samples, guaranteed to be a fair representation of the quality of the cotton in the bales from which they have been taken, and he proceeds to make his selection in the manner indicated in previous answers.

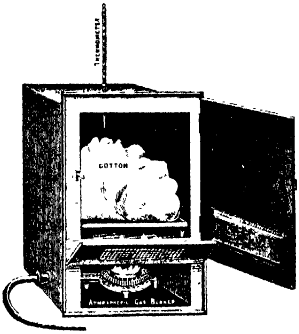

FIG. 1.

Referring to the test for moisture, an oven may be used such as shown in Fig. 1. Small samples may be taken from the centres of several bales, and about 1,000 grains weight of cotton in this way made up out of various samples.

This 1,000 grains of cotton may be placed in the oven and subjected to a radiated heat of perhaps 180° F. or more for, say, a period of one and a half hours. After being taken from the oven it should be re-weighed, and the percentage of loss can be readily ascertained, owing to the level quantity of 1,000 grains being taken. It has been found by experiment that cotton tested in such a manner may be expected naturally to lose 8 or 8½ per cent. of moisture. Suppose the oven shows 13½ per cent. of loss, then we may say about 5 per cent. or so of this is added moisture.

Q. 1899. You are supposed to be buying cotton for a mill spinning warp and weft, counts 40's to 50's. The twist yarn must be strong and wiry, and the weft moderately soft. What kinds of cotton would you buy? What qualities would determine your selection, and how would you fix the price? Assume that colour is not of much importance.

A For a strong, wiry, twist yarn of 40's to 50's almost any of the Brazilian cottons, such as Pernams, Maranhams and Ceara, would do very well; while for a moderately soft weft of the same counts Orleans would do. For high qualities of these counts brown Egyptian cotton is often used.

The qualities that would determine the selection would be length, strength, uniformity and cleanliness of fibre, and we should determine these qualities by pulling tufts of the fibres between the finger and thumb of each hand, by feeling at the cotton and by shaking it. These qualities and the price of the cotton must be ruled largely by the price we expect to sell the yarn at, being not so high as to prevent the likelihood of profit, nor so low as to give such bad spinning and poor yarn as to drive away the customers.

Q. 1899. If you were asked to buy a quantity of cotton for spinning, what properties would you examine it for, and how would you arrive at its relative value? If you paid cash what terms would you expect to get?

A. The leading principle in buying the cotton would be to see that it was suitable for the counts and description of yarn it was intended to spin from it. There is always a temptation to buy cheap cotton because, say, one-eighth of a penny per pound of cotton makes a large difference in the profits of a spinning concern if the price of the yarn can be kept up. If, however, the cotton costs one-eighth of a penny less and the yarn is so much worse, that, say, one-eighth of a penny per pound less is got for the yarn, while in addition there is a greatly increased percentage of waste and much trouble with the operatives and lessened production, there can scarcely be much true economy in buying the cheap cotton. The cotton should be of proper length of staple, possess the required degree of cleanliness and freedom from impurities, neps and short fibre. Uniformity of staple is also an important property.

The usual method of testing for length at Liverpool is to pull and reduce a small sample between the thumb and forefinger of each hand until a few fibres are obtained, from which the approximate length of staple can be determined, and also an idea of the strength.

By shaking a small portion of cotton in the light of the window an approximate idea may be conveyed to the mind of an expert as to the relative amount of dirt.

As regards terms of purchase it is usual to allow 1½ per cent. net discount for payment in ten days, and this is accompanied by a further allowance of 5 per cent. per annum for the number of days the cotton is paid for before the ten days are up. If payment is delayed after the ten days, 5 per cent. per annum is added for the extra time.

Q. 1896. Upon what terms is cotton usually bought from the Liverpool brokers? What is the allowance for tare?

A. As stated above the terms upon which cotton is usually bought in Liverpool are: Ten days' credit less 1½ per cent., with an allowance of 4 lb. per cent. for tares. If the payment is made before the expiration of the ten days, 5 per cent. interest is allowed on the account for the time gained, and on the other hand, if payment is delayed beyond the ten days, 5 per cent. interest is charged on the account for the extra days. For instance, suppose payment is made four days before time, then 1½ per cent. would be deducted from the account, and 5 per cent. on the account for the four days. The latter amount, however, would not be very great, as it could only reach £5 on every £100 in twelve months. For four days on £100 it might be 1s. 1d., as shown below:

365 : 4 : : £5 : 1s. 1d.

It is also specified that falsely packed, damaged or unmerchantable cotton will be allowed for at the value of the sound cotton if the claim be sent in within a certain time limit.

CLASSIFICATION OF COTTON.

The chief contributors to the European supply are, in the order of their importance, as follows: The United States, India, Egypt, Brazil and Peru. Besides the cotton indigenous to most of these countries, nearly all produce different varieties, generally grown from seed of the most popular kinds cultivated in the United States. The following are those usually quoted in the *Liverpool Cotton Brokers' Circular;* to them are appended brief descriptions of their important characteristics:—

Length of Staple.
Fineness.
Strength.
Smoothness.
Colour, and
Cleanliness.

American varieties are classed in four qualities—good ordinary, low middling, middling, and good middling; South American, three—middling fair, fair, and good fair; Egyptian, two—fair, and good fair; East Indian, three—fair, good fair, and good. Standard samples of these classes are preserved for reference, in case of dispute, in the offices of the Liverpool Cotton Brokers' Association; and it is customary amongst brokers to form a set of the classes in which they deal, and, after careful comparison with the standards, to preserve them for easy reference when required. As, however, the crop of each succeeding year differs in some important respect from its predecessor, these standard samples are subject to considerable modification. According to the relative abundance or scarcity, fulness or deficiency, of special characteristics the different varieties are classed up or down, as the case may require. Thus, within a limited range, there is a constant fluctuation of the standard.

Q. What are "spot," "arrivals" and "future" cottons, and what are the conditions governing transactions in them?

A. "Spot" cotton means cotton that is actually on the "spot" or in the market, actual samples of which are inspected by the spinner prior to purchase. By far the greater proportion of cotton for actual use is bought on the "spot". The terms of purchase have been previously given.

A good deal of business is now done in what is sometimes termed "arrivals" cotton, or more often termed "C.I.F." cotton. These letters are brief for cost, insurance and freight. Such cottons are not actually at Liverpool, but are due "to arrive" within certain time limits. The purchaser does not see samples of the actual cotton, but it is agreed that the cotton shall be equal to certain type samples. The seller of the cotton at the foreign market pays costs, insurance and freight, the spinner being responsible when the cotton is delivered on the quay at Liverpool. The cotton may be forwarded directly to the mill without storage in Liverpool warehouses. The other terms for "C.I.F." cotton are much similar to those for "spot" cotton.

"Futures."—It is in "futures" that a vast deal of speculation or gambling in cotton is often done, there being many persons who make it their business to speculate in cotton quite apart from the question of serving spinners with cotton for use. The term *bull* is sometimes applied to a buyer of "futures," and the term *bear* to a seller of "futures".

A point in England is $\frac{1}{64}$ of a penny. It is possible for a spinner to buy "futures" cotton as a cover for large forward sales of yarn. "Futures" may be bought on a basis of, say, 5d. per lb. for middling American, and the contract may be made, say, in January for termination in April or May.

In the intervening time "weekly settlements" are made, by which the spinner pays or receives the difference in the market value of his "futures" contract.

Q. Name the principal properties of cotton, as a spinning fibre, in their order of value. Give reasons for your answer.

A. Natural twist is the most important of the features which render cotton so eminently fitted to hold commercial supremacy amongst other textile fibres. If, for instance, flax were cut to the same length as an ordinary cotton fibre, it would be difficult to make the fibres adhere to each other, although there is no difficulty experienced with the cotton fibres. Nay, further than that, they have a strong natural tendency to stick to one another because of this natural twist. As to its extent and cause, we dealt with the matter in the first year book. A quality which—although not physical—undoubtedly has a great deal to do with its commercial supremacy, is the ease with which it can be cultivated and

CHAPTER II.

THE PRACTICAL MANIPULATION OF COTTON SPINNING MACHINERY.

BLOWING-ROOM.

Q 1899. If, on examining a lap produced on a finisher scutching machine, you found it (*a*) uneven in weight, (*b*) ragged at the edges, (*c*) splitting, where would you expect to find the causes of these defects, and what would you do to remedy them?

A. As regards unevenness it would be advisable to examine all parts of the feed regulator motion to see if they were in satisfactory working condition. The bowl box should be kept well cleaned; the cone belt should be kept at a fair degree of tension. For the same defect care should be taken to have the laps presented to the back of the finisher in as regular a condition as possible, and everything affecting the fan draught should be carefully examined. For bad selvedges care should be taken to avoid any rough places on the sides of the scutcher between the beater and the cages. Every attention should be bestowed upon the efficient lining of the cages at the ends. A practice now sometimes adopted to improve the lap edges is to make the laps at the front narrower than those in the creel of the scutcher, and to repeat the narrowing process behind the card. Lap-licking or "splitting" is often a very serious evil in a spinning mill. When a large quantity of soft waste is used in the cotton it is sometimes the case that a drag board is allowed to press against the lap during formation. In other similar cases a number of rovings are allowed to run in with the lap during its formation. The more efficient blending of cotton, using a less amount of short fibre, making the top cage of the scutcher larger than the bottom one, are other remedies for "splitting".

Q. What fault is caused by each of the following derangements of the piano motion? (1) Fork in cone drum box too wide; (2) pendants and bowls slack in bowl box; (3) cleaning neglected between the cotton holders.

A. In each of the three cases specified the effect would be dilatory action of the cone drum belt, and therefore ineffective regulation of the lap by the piano motion. A slack cone belt fork would mean a loss in touching the belt by the fork at every change, and slackness in the bowl box would mean a loss between the bowls and pendants, while neglect of cleaning would cause the various parts to bind and work sluggishly. In the case of worn pendants an alteration in the height of the bowl box has sometimes been a good thing.

As a matter of fact, because of wearing and neglect of cleaning and friction of these parts, some spinners are now adopting new regulating motions, in which the bowl box is dispensed. In one of these cases spring balances are used, and in another tripod levers instead of the usual pendants.

Q. 1900. It is necessary to cleanse a scutching machine periodically. Name the parts which require cleaning, those which need most attention, and describe fully and in what order you would proceed to clean them. If you were scutching low middling American cotton, how often do you think you would need to thoroughly clean?

A. The parts of the scutcher which need most cleaning, apart from the usual weekly wiping down, are the lap end, the regulator motion, the beater bearings, the beater and cage bars, and the interior sides of the machine.

At intervals of, say, once per month—more or less according to individual cases—the calender rollers and fluted lap rollers are lifted out and the bearings thoroughly cleaned and re-oiled. It should be stated, however, that in some mills this work is only done at intervals of several months.

The rollers themselves and the cages may be well rubbed with a blacklead brush, or whitening or French chalk, and then the machine made good again.

At intervals of perhaps the same duration the bowl box of the piano feed regulator may be pulled to pieces, all the parts thoroughly cleaned, and blackleaded, and then replaced.

The same with regard to the beater bars and cage bars and insides of the machine, in order to make the passage of the cotton as free as possible.

This foregoing work is often done at the week ends, and it is often found convenient to do part of it at one time and part at another.

Q. 1899. How would you set the feed roller or pedal nose of a scutching machine relatively to the beater if you were preparing laps (1) from Tinnevelly, (2) from Uplands, (3) from Egyptian cotton? If the beater was 18 inches diameter, with two blades, and revolved 1,200 times per minute, what number of inches of lap would you deliver by the feed roller per minute if you were scutching American cotton?

A. We should not be far away from good practice if for Tinnevelly we set the beater blades to be about $\frac{1}{8}$ or $\frac{3}{16}$ of an inch from the bottom feed roller, and about $\frac{3}{16}$ or $\frac{1}{4}$ of an inch away for Uplands, and, say, $\frac{5}{16}$ or $\frac{3}{8}$ of an inch away for Egyptian cotton. It must be remembered, however, that with the closest setting the blow of the beater will always be delivered on the cotton at more than 1 inch from the point where the cotton is gripped between the top and bottom feed rollers. As a matter of fact, if the cover of the beater be lifted up it will usually be observed that, say, about 1½ inch of cotton are hanging down from the feed rollers. The setting at this position is ruled somewhat by the same general law that rules the setting of drawing rollers, *viz.*, the longer the staple of the cotton and the further away the rollers, the number of laps put up together also affecting the problem. With the pedals in place of the bottom feed roller it would be possible to bring the grip of the pedal and the top feed roller nearer to the striking point of the beater. As regards the rate of feed per minute, this would vary considerably in different mills, and will probably be somewhere between 60 and 80 inches per minute. Taking 80 inches per minute, this, of course, would be 80 inches to 2,400 strokes of the beater, which would equal 30 strokes per inch of cotton fed.

Referring to Figs. 2 and 3, in each case A is the pedal nose; B, the pedal roller; C, one blade of the beater; D are the feed rollers in Fig. 2. The arrangement in Fig. 2 is for long staple cottons. Fig. 3 is used for short staple cottons, and also for long staple cottons in openers where porcupine cylinders are used.

Q. Describe the derangements which are liable to take place in machines in the blowing-room, and the manner in which the cotton passing through is injured by the occurrence of these derangements.

A. It is possible that the faulty action of these or other machines may be due to defects in their construction or to derangements which arise in their manipulation. (*a*) In actual work the author has often witnessed *bad edges* made

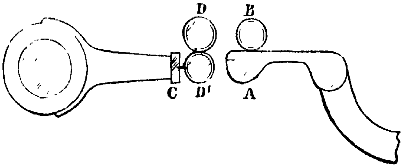

FIG. 2.

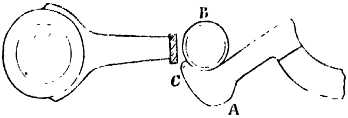

FIG. 3.

on the laps by pieces of cotton sticking to the bars of the leaf extractor, or to the sides of the machine between the cages and beater. Defective linings to the ends of the cages, or in efficient covering up or recessing of the ends of the cages, will lead to the same evil, and so also thin feeding at the edges of the feed lattice.

In some cases bad selvedges have resulted from trying to make too thin a lap sheet, and in others by having dirty cages or air exits.

(*b*) *Uneven laps* often constitute a most serious evil, and may be caused by numerous circumstances, the primary of which are defective action of the piano feed regulator and irregular feeding of the cotton. This evil may result from the various doors and covers of the machine not being made a sufficiently good fit, and thus affecting the air current. Possibly, also by dirty dust flues and wrong speeds of fan.

The hopper feed may be wrongly proportioned in speed to the opener feed rollers, or some of its parts may be out of order.

As regards the feed regulator, the cone belt should be kept in a flexible condition and of the proper tension. Worn bowls should be renewed, and slackness in the various studs, rods and levers should be avoided. It may be noted that feed regulators are now receiving more or less adoption, in which the troublesome bowl box is entirely dispensed with.

Systematic weighing of the whole lap, and of small portions of lap, is essential to secure uniformity. Every opener or scutcher is provided with small adjustment screws to vary the weight of lap readily.

(c) *Lap licking* is a serious evil in many cases, and may be due to using too much waste or short fibre in the mixing; or to not having the top cage of larger diameter than the bottom one; or to not having most of the draft in the top cage; or by too much resistance on the *brake* motion for hardening the lap. In extreme cases sometimes slubbing or intermediate ends are run round with the lap, or a drag-board is made to rest on the lap during its formation, or the lap is thickened.

(d) If uniform laps and freedom from breakdowns are to be obtained from these machines, the utmost care should be taken to ensure really efficient cleaning and oiling of the various parts. Also all the straps should be kept well up in tension, and the various rollers and shafts should be known to work freely in their bearings.

(e) Sometimes the proper dropping of the leaf extractor door, or the removal of the fly and dirt from the proper positions, are neglected so much that some of the impurities begin to pass with the good cotton. The same effect may be produced with an excessively strong fan draft; while, on the other hand, if the air current be too weak, there will be a danger of good cotton passing with the impurities.

(f) If the beater speed be too high, or if the feed rollers or pedal noses be set too close to the beater, there will be a tendency to cut the fibre. Setting too far away, on the other hand, may tend to take the cotton forward irregularly, and nip and string the fibre by allowing it to hang down from the feed rollers and be struck by the blades repeatedly.

It is possible the latter evil may also be caused by worn beater blades. When it is remembered that in a two-bladed beater each blade strikes the cotton on an average upwards of 60,000 times in an hour, it will be understood that in process of time the steel blades may become worn. Sometimes the blades are double edged, and the beater is reversible so as to allow of bringing the unworn edges into action. In other cases they may be re-planed.

(*g*) If the stripping plate be set too far away, it allows the cotton to be carried round by the beater, resulting in *overbeating of the fibre.* As regards constructive evils, it is possible:—

(1) That the ends of the cages may be not properly recessed into the machine.

(2) That rough places may be left on the insides of the machines, so that cotton will catch on them, the latter evil also resulting if the cages and various rollers are not well finished.

(3) The various rollers, cages, beaters, fans, etc., may be not set to work with sufficient freedom

(4) The various doors and covers and the fan-box may not be airtight.

(5) The feed rollers may not be of sufficiently large diameter, or may be ineffectively weighted, resulting in the cotton being *plucked* from them by the beater, in unopened lumps of fibre.

(6) Sometimes the pedal noses are not suited to the staple of cotton being used.

(7) The various mechanical drafts of the machine may be wrongly proportioned.

(8) Sometimes inadequate provision is made for adjustment of the feed rollers, stripping plate and other parts.

Bayne's Regulator.

In this motion the bowl box is entirely dispensed with. A heavy bar is hung from the rear of the pedal levers by a set of spiral springs, there being one spring to each lever. The springs used are of the well-known Salter's make, as used in the well-known Salter's spring balances, being of uniform strength and size. The long bar rises and falls in accordance with the average rise and fall of the pendants. This bar is kept suspended in such a manner that its centre of gravity is always the same distance below the average of the pedal ends, however irregular the individual heights and positions of such pedal ends may be. To obtain this effect, the increased pull of some of the pedals and springs is compensated for by the decreased pull of others, and, consequently, the rise and fall of its centre of gravity exactly corresponds to the increase or decrease of the thickness of the sheet of cotton.

Within the hollow of the long bar alluded to, and pivoted at its centre of gravity, is a lever, one end of which is adjustably secured to a link fixed to the framing by regulating nuts, while the other end works directly in connection with the strap fork of the cone drum belt.

The author witnessed this motion at work some three years ago, and it was undoubtedly giving satisfactory regulating, in addition to the advantages attendant upon dispensing with the bowl box.

The Tripod Regulator.

Fig. 4 shows another form of feed regulator which appears to be receiving some amount of adoption, and is much similar to one the author saw working on a scutcher of foreign make at the Paris Exhibition. At least one firm in America also appears to be making a modification of this arrangement, and another modification of the same idea appears to have been at work on the Continent for many years.

The "Tripod" regulator (shown in Fig. 4) is made by Messrs. Lord Bros., of Todmorden, and is so named by its essential feature, which is that a number of three-armed or triangular levers of various sizes are used in place of the ordinary bowl box arrangement. The arrangement can be applied to existing scutchers.

The makers themselves *claim* the following advantages:—

(1) Greater effectiveness.

(2) Its efficiency is not impaired by any wear.

(3) It never requires cleaning, as it will work when covered with dirt.

(4) Time and expense of cleaning obviated, thus saving,

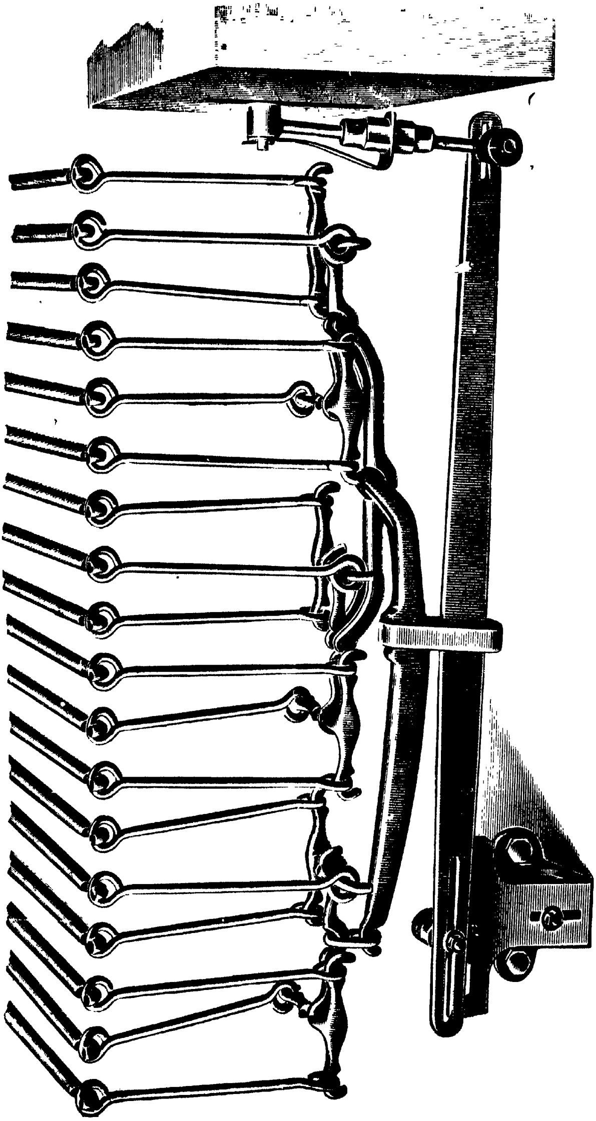

Fig. 4

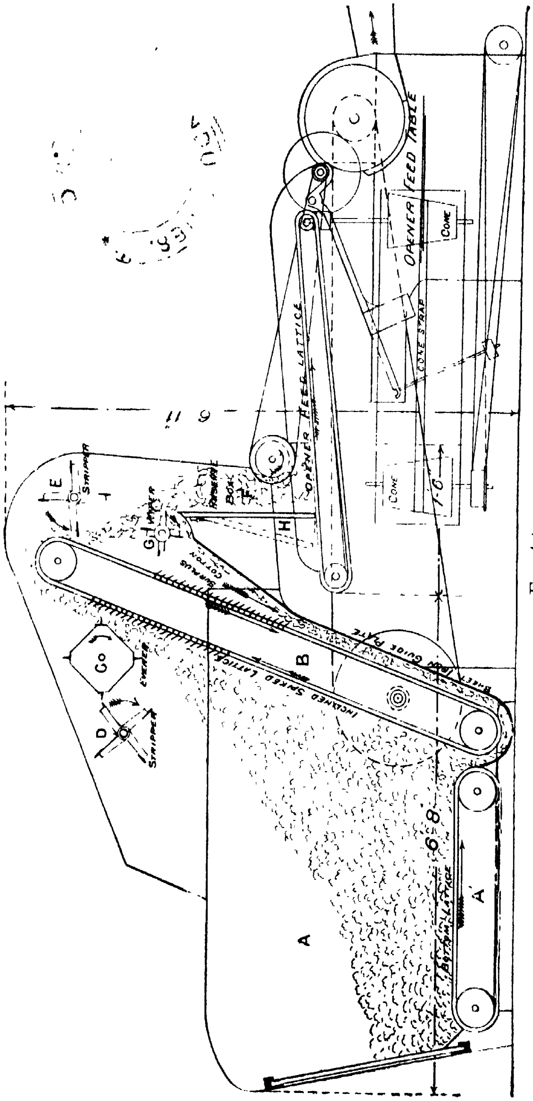
STRIPPER
E
WIPER
G
RESERVE BOX
F
H
C
OPENER FEED LATTICE
OPENER FEED TABLE
CONE
CONE STRAP
9' 11"
1' 6"
SURPLUS COTTON
SHEET IRON GUIDE PLATE
INCLINED SPIKED LATTICE
B
EVENER
D
STRIPPER
A
6' 8"
BOTTOM LATTICE
A'

FIG. 4 (a).

also, chance of bad work through the regulator not being put together properly after taking to pieces to clean.

(5) No repairs ever required.

(6) No bowls between the pendants are used, so that the regulating cannot be spoiled through flat places wearing on such bowls.

(7) No lubricant required.

(8) Cannot get out of order.

(9) Working much more freely than the ordinary regulator, it puts very much less strain, and consequently less wear and tear, on the feed roller flutes and bearings.

(10) The cone-drum strap may be tight without affecting its sensitiveness.

(11) Gives such accurate work that for weeks its adjusting screw need not be touched.

(12) From its extreme simplicity it gives less trouble and greater "yard by yard" regularity than any regulator yet made.

(13) Can be readily applied to any kind of piano regulator.

It remains to be seen whether more extended trial will lead to the general adoption of this or similar motions.

Hopper Feeder.

In addition to the hopper feeder arrangements shown in the first year's section of this work, it may be advantageous here to illustrate the hopper feeder as made by Messrs. Lord Bros. Fig. 4 (*a*) is a longitudinal section of this feeder, and is practically self-explanatory. A is the feed box; A′, bottom lattice; B, the lifting lattice; C, the evener roller; D, cleaner for C; E is the stripper roller.

A special feature is the "surplus" cotton arrangement mark behind the spiked lifting lattice, its object being to return overflow cotton from the reserve box into the feed box again. The reserve box itself is a feature not found on all hoppers.

This hopper can be, and preferably is, driven from any convenient shaft, independent of its opener or scutcher.

It is also desirable to drive the inclined spiked lifting lattice that has the most work to do independently of the regulator, so as not to impose too much work on the cone regulator of the opener or scutcher.

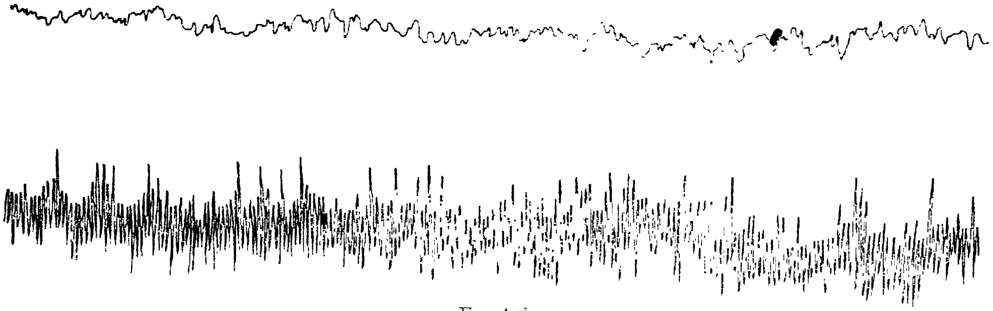

Fig. 4 (b).

At Fig 4. (*b*) are two diagrams intended to show the improvement in the uniformity of feed obtained by applying this machine.

CARDING ENGINES.

Q. 1900. Say what you know about the procedure necessary to keep carding engines in good working order. How often would you strip, grind and generally overhaul them if you are carding (*a*) a good middling American or (*b*) brown Egyptian? If in grinding you found the points very dull, how would you proceed?

A. To keep carding engines in good working order it is necessary, in the first place, to see that "stripping" and "grinding" and "setting" are performed with sufficient frequency and skill. It is essential also that the cards be kept well cleaned and oiled, and with the straps and bands at a proper tension. Broken parts and damaged wire should be made good as quickly as possible

The frequency of stripping and grinding varies considerably with different firms. For either of the above cottons stripping may be done from two to four times per day. With hardened and tempered steel wire some firms lightly grind the same cylinder every fortnight or every week; in other cases it is done once per month, while in still other cases a much longer interval is allowed to elapse between grinding.

As regards thoroughly re-setting, this may be done once every six months. Doffers may be set to cylinders rather frequently.

If the points were found to be very dull it would be best to first apply the full length or so called dead roller in order to grind more quickly. Afterwards the Horsfall might be applied to give a final and more accurate grinding.

Q. 1899. The flat strips on a revolving flat card are found to be (*a*) uneven in weight compared with each other; (*b*) uneven at various parts of the same flat; (*c*) too heavy in each case; (*d*) stripping badly. What are the causes of and how would you remedy each of these defects?

A. (*a*) The wire on some of the flats may be damaged, or the ends of the flats may be worn irregularly, thus giving a different angle to the flats, or parts of the chain may be irregularly worn, or the wire foundation may be slack on some flats. (*b*) The wire may be damaged at one part of the flat and not at another, and the same remark applies to slack foundation The front plate may be set further away at one end than the other. The wire may be harder and rougher and not as well ground at one place as another. (*c*) A common cause of the flat strips being too heavy is the front plate between the last flat and the doffer – being too far away. There may be an improper angle in the teeth of the flats, such as having too much "keen" (*d*) A common cause of flats stripping badly is the stripping brush being set too deeply, and this has frequently come under the author's notice. When an operative sees the flats stripping badly and has not had previous experience--he at once naturally gets the brush to touch the bottom. This, however, aggravates the evil by fastening the fibre at the bottom of the teeth Defective wire is a common cause of bad stripping.

Q. 1900. If, having charge of revolving flat carding engines, you found some of the webs with cloudy or bare places, to what causes would you attribute, and how would you remedy, either fault?

A. Speaking generally, irrespective of maker of card, there are many good carders who immediately make a point of examining the feed parts of a card in the case of cloudy webs to see if there is irregular or defective setting of the feed roller, taker-in and possibly the back plate. An uneven lap sometimes allows plucking, and therefore gives cloudiness.

Temporary cloudiness of the web is sometimes caused by neglect of stripping, and the carder generally has an idea when such is the case. Very wide setting of various parts will cause cloudy webs, and this remark applies, perhaps, more to the setting of the doffer from the cylinder than to anything else. Neglect of grinding will cause cloudiness.

In some cases cloudy webs have been traced to the influence of air currents acting on the cotton on the face of the cylinder, more especially at the front and back plates, and in other cases the cause has been found to be the defective condition of some parts of the wire. Bare places may be caused by defective laps, and by one or two of the things which also cause cloudiness. The remedies are obvious.

Neglecting to collect fly from beneath the card may lead to cloudy webs, and especially from the front edge of the undercasing. By reversing the doffer by hand such accumulations may be brought off with the doffer, and this is often the first thing that grinders do.

Q. 1898. Having charge of carding engines, what would you do if you found that cloudy or uneven webs were coming off the doffer? Where would you look for the fault, and how correct it?

A. It would be an easy and profitable thing to first of all strip the card well, and note the effect on the web. Afterwards the gauges might be inserted in order to get an idea of the distances apart of the main working parts. These being all right, the wire might be examined carefully as to whether it required grinding. It may be taken as a fundamental principle that defective stripping, grinding and setting are fruitful causes of cloudy webs. The wire itself, of course, in process of time requires renewing. The lap behind the card must necessarily receive early attention at our hands, especially with reference to the special defect of unevenness, as it will be practically impossible to secure regular web from an irregular lap. The edges of the lap can soon be examined, and if any doubt exists as regards the regularity portions of two yards long should be unwound from it and carefully examined and weighed. Imperfect action of the doffer comb at times tends to bring the web off the doffer in a cloudy and uneven condition, especially the first thing on a cold frosty morning. See also previous answer.

DOBSON'S PATENT FLAT GRINDING APPARATUS.

This patent anti-flexion apparatus for grinding the revolving flats is applicable to, and can be adapted to, cards of other makes, as a rule, with very little trouble, as well as to the cards of the same firm.

They mount the apparatus immediately over the taker-in, in a bracket upon which are formed two surfaces at different levels, to correspond with the angle of the flat. Underneath this fixing, and attached to it, is the grinding roller bracket, both brackets being adjustable in either direction.

The flats are conducted in a straight line, by runners or bowls, while passing over the grinding roller.

The makers *claim* the following advantages:—

(1) There is no moving part in the motion controlling the grinding.

(2) The ordinary size of grinding roller can be used.

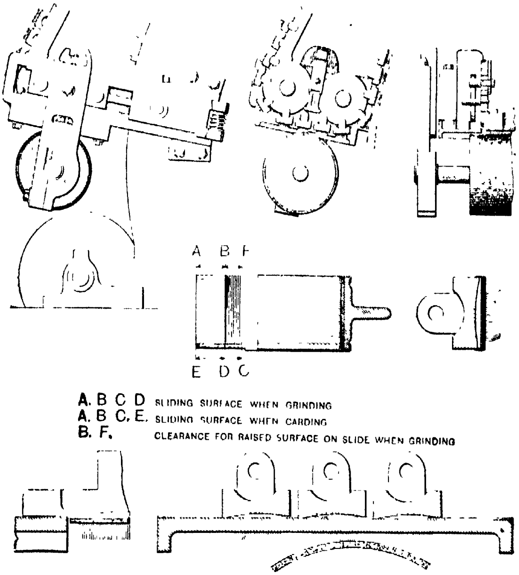
A
B
F
E
D
C
A. B C D SLIDING SURFACE WHEN GRINDING
A. B C, E. SLIDING SURFACE WHEN CARDING
B. F. CLEARANCE FOR RAISED SURFACE ON SLIDE WHEN GRINDING

FIG. 4 (c).

(3) There is no movement in the axis of the grinding roller itself.

(4) When the flats are passing over the grinding roller they are subject to no strain whatever.

(5) When the flats are being ground they have the wire downwards under the same conditions as their working position.

(6) Each flat on the card is bound to be precisely the same

as the other flats—there is no possibility of its being otherwise.

(7) Whatever the wear and tear on the end of the flats it is regulated by the grinding roller.

(8) There are no corners or shelves for the lodging of fly or dirt.

(9) The grinding surfaces are automatically cleaned by the passage of the flats.

(10) The motion requires absolutely no attention.

(11) The setting of the grinding roller is more steadily executed, as the motion is in the most favourable position for doing this.

(12) Any dirt loosened in the flat wire by the vibration of the grinding falls on to the steel cover of the licker-in and cannot get into the card.

Q. Describe the remedies for the following derangements in a carding engine:

(1) Web hanging or bagging between calendar and doffer.
(2) Flocks forming at the side of the web.
(3) Web following doffer instead of stripping clearly.
(4) Flat strips leaving flats in a continuous web instead of being merely joined by a few fibres.

A. (1) In certain definite experiments and alterations the author found that putting doffer comb to make its stroke lower down caused the web to bag or hang down, and if carried to excess broke the web. A remedy might therefore be found in such cases by shortening or lifting the stroke of the comb.

It might happen in some cases that the calendar rollers were running too slowly, and, without doubt, speeding them up would tighten the web.

(2) It has often happened that flocks, or bunches of fibre, have been formed at the edges of the cylinder and doffer, and some of them have passed forward with the good carded cotton. Often this evil has been due to defects in the construction of the card, and it has been a very difficult matter to provide an effective remedy.

Formerly wooden linings were at the ends of the cylinders, and the replacing of these has diminished the evil of flocking. There has always been a tendency for the emission of fly at the ends of the cylinder, and these have been rubbed into flocks by the end of the cylinder against the lining.

In modern cards flocking is much less prevalent than formerly, due to the great pains taken to provide efficient casings and covers to the ends of the taker-in, cylinder and doffer. In any case keeping the fly well cleaned from the ends in question will diminish any tendency towards flocking.

(3) A remedy for the web following the doffer might be found in setting the doffer comb closer to the doffer, or a little lower down, or in speeding up this comb.

(4) As a rule, when the flats leave the cylinder in a continuous web, it is because the top edge of the front plate is set too far away, and in any such case the first thing to be done should be to set this plate closer to the cylinder.

Q. What is the result upon the cotton passing through the cards when the rollers or flats are set too near the cylinder, and also when too far from it?

A. As a matter of fact these parts can scarcely be set too near without absolutely touching, except in the case of very heavy carding.

Actual contact would probably damage the wire more than the cotton, but the quality of carding would afterwards suffer owing to the damaged wire. Actual contact, or extremely close setting with heavy carding, might cut, break and nep the fibre.

In the case of the flats being too far away we might expect dirty and cloudy webs, owing to the fibre getting into the toe of the flat, and the flat being so far from the cylinder that the latter could not again take the fibre from the flat in a proper manner, while at the same time the dirt could not be properly transferred from the cylinder to the flats.

Q. What are the particular merits of the Wellman and the revolving flat cards?

A. Although the Wellman card is now seldom or never made in England, there are some good spinners and practical men who yet consider it to be far ahead of the revolving flat card as regards the quality of the work done, without injury to the fibre, at any rate for fine spinning.

Taking the revolving flat card first, it may be said that its great superiority consists in the much larger quantity of work capable of being turned off, combined with a much smaller amount of attention required.

The setting of the flats is far more easily done than on the Wellman, in which each flat requires individual setting. There are far more flats and a great deal more wire capable of being brought into action on the cotton.

The stripping of the flats is performed on the whole in a much better manner than on the Wellman, in which latter card each flat has to be lifted up away from its work, thus leaving a bare place on the cylinder while the flat is being stripped.

The grinding of the flats can also be done without disturbing the flats or stopping the card, which is not practicable with the Wellman.

In favour of the Wellman it may be said:—

(1) Coarser can be used on the back flats than on those towards the front of the card, thus giving a graduated action of the flats.

(2) At the same time we may have more bevel or wider setting of the back flats than the front ones.

(3) Another important advantage is that the back flats, being dirtier than the front ones, can be stripped more frequently than the front ones, say twice or three times for the back flats to once for the front ones.

Quite recently the author went through a noted fine spinning mill in which all the cards were of the Wellman flat type.

It may be added that this card is named after its original inventor, *viz.*, George Wellman, of the United States of America.

Q. There are three ways of increasing the weight of carding or production in a given time: first, by increasing the thickness of lap; secondly, by increasing the speed of the feed rollers by means of a larger side shaft change bevel; thirdly, by increasing the speed of the doffer. Under what conditions do each of these three methods recommend themselves?

A. (1) Speaking generally, the best and most usual method of increasing the production of the card is to put on a larger Barrow change wheel. This speeds up the doffer and coiler parts at the front of the card, and by means of the side shaft it speeds up the feed and lap rollers at the back of the card.

The beauty of this alteration consists in the counts of lap and sliver remaining unaltered, while the change can be readily effected. The quality of carding would be rather worse.

(2) It might happen that our scutchers had already a difficulty in providing sufficient laps for the card, and in such a case it would probably be necessary to increase the thickness of the lap. This would alter the counts of sliver, which is usually undesirable. In cases, however, where we were going upon coarser counts, we might require a thicker sliver, and it would then be probably the best thing to increase the lap thickness.

(3) It might happen that we had plenty of laps from the scutcher, and the weight of lap per yard was as heavy as it was considered advisable to have it. At the same time we might desire a coarser sliver owing to coarser counts, or again our drawframes could take a thicker sliver, but could not conveniently use up more length of sliver. In such cases a larger side shaft change bevel could be put on. The two last changes would give more weight of sliver, but the same length, while the first change would give more length of sliver of the same weight per yard.

Q. 1898. If you found a carding engine making too much waste, how would you proceed to remedy it?

A. This would, of course, depend upon how and where the waste was being made, which to a large extent would very soon enable a practical carder to localise the cause and remedy the defect. If the undercasings of the taker-in were set too far away from the taker-in or from the feed plate, or the mote knives too close, or the feed plate was too far away from the taker-in, we might expect to find too much waste beneath the licker-in. It is possible that the extra waste might be caused by the flat strippings being too heavy, when it is probable that the front stripping plate would be too far away, the remedy being in this, as in the previous cases, very obvious. Occasionally the strips might be too heavy at one side only, when it is probable the front plate would be too far away at that side only of the card. When a card is old, out of truth, and covered with bad wire, it is natural to expect too much waste from these causes. It might be that the extra waste was due to the presence of an excessively large proportion of short fibres in the cotton, and this of course should be borne in mind and attended to.

Q. 1897. How would you proceed to grind the clothing on a carding engine cylinder (1) when newly clothed, (2) after ordinary wear? State the reasons for the course you adopt.

A. When intending to grind a card, the feed should be stopped and the card run thoroughly bare, this operation taking anything from half an hour to an hour, according to the speed of the card. As the flats are ground in position with the card working, the question refers doubtless to the cylinder and doffer. The covers for these are removed so as to expose the wire to the action of the grinding rollers. There are differences of opinion as to the use of the Horsfall, or the full length grinding roller, some men preferring to use the latter first, but finishing off with the former. The cylinder must be reversed in direction during grinding, as it would be difficult to get enough difference in surface speed between the grinding roller and the cylinder if both went the same way. The doffer, of course, is not compelled to have any such reversal, as it always, during working, revolves the contrary way to the setting of its teeth. It is a matter of opinion as to whether slow or fast grinding is the better, and the practice is therefore subject to variation in this respect. Slow grinding, however, is not much used. It may just be remarked that in slow grinding the speeds of the cylinder and doffer are much reduced, while in ordinary grinding the cylinder remains at its working speed, and the doffer is speeded up. As regards the difference between grinding a new card and a card that has been working for some time, in the case of the former there would, of course, be no necessity for running the card bare, as the cylinder, flats, doffer, etc., would not be charged with cotton. In the natural order of things it would probably take longer to reduce the wire of the new card to a satisfactory condition, and this would necessitate a longer time of grinding. In either case the requisite cords or belts would have to be applied for driving the cylinder and doffer and the two grinding rollers.

Fig. 5 shows a card set out for grinding. A is the cylinder driven by the crossed belt, and revolving during grinding upwards from the doffer. An open belt on one side of the card gives motion to the doffer, B, and on the same side two cords give motion to the grinding rollers, *a*, *b*. It is presumed that Horsfall grinders are being used with pulleys on each end. The opposite figure shows the driving of the pulleys on the other ends of the rollers by means of a triangularly disposed belt.

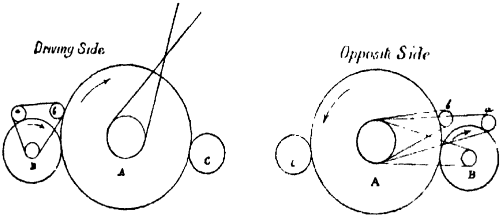

FIG. 5.

NAILING-ON CARD APPARATUS.

For fillets and sheets usually now machines are used to assist in "nailing on," and Fig. 6 is an example of such.

It is introduced to facilitate the laying of cards, whether in sheets or in fillets, on carding engine cylinders, and is equally applicable for wollen as for cotton cards, and for wood and iron cylinders.

For laying fillets, a small worm wheel is used for small cylinders, and a large wheel (No. 1) for large cylinders.[1] The

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[1] In laying sheets, the rest, carriage, ratchet, and pliers alone are used. The rest is fixed behind the cylinder, and the ratchet (No. 6), to which the pliers (No. 7) are attached by a strap, is fixed on the carriage (No. 8) in place of the drum (No. 5) The sheet is first nailed on the cylinder by its upper edge, and is then stretched as much as required by pressing down the lever (No. 6), when sufficiently stretched, the thumbspring being let go, the ratchet holds the card until nailed; the carriage is then wound along the bed, and the operation repeated. The cylinder is held stationary, during stretching, by suitable catches.

For turning-up wood cylinders a turning tool is fixed on the carriage (No. 8) and worked along by the rack and pinion. Card sheets and wood cylinders are quite *obsolete* in cotton spinning.

The complete apparatus includes rest 60 inches long, carriage, drum, ratchet, two wheels, wheel support, turning tool and holders, card pliers, strap, catches, screw-keys, &c.

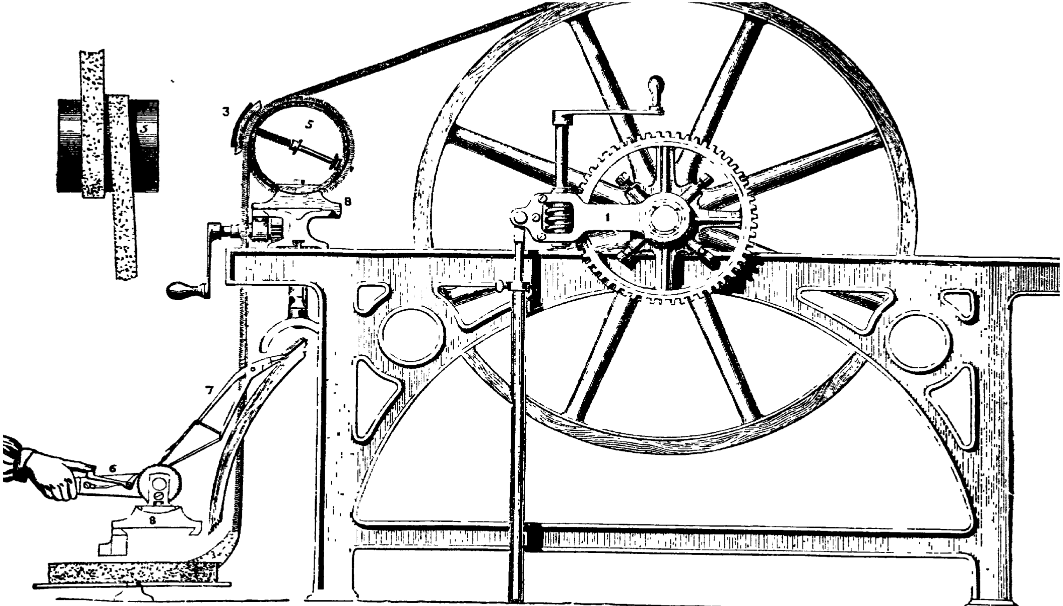

FIG. 6.

wheel required is fixed on the end of the cylinder shaft by four screws shown, and as great power is obtained by use of the worm and worm wheel, the cylinder is not very hard to turn; the leg support is to keep the wheel in the proper position. The slide is placed at the back of the cylinder, and the fillet is placed two turns round the drum (No. 5), passing under the back board (No. 3), the required friction being given by the screws, spring and nuts inside the drum; this back board is covered inside with emery, and the card in passing under is slightly sharpened at the tips, which is found an advantage; the fillet passes over a curved roller, and is thus caused to lie flat on the cylinder. The card-nailer stands opposite the cylinder, and, by the rack and pinion, moves the drum along as the card is laid, putting in the nails as required. By this means a perfectly even surface of card is obtained, and the work is done at much less cost and in a more superior manner than by the old process.

Fig. 6 (*a*) shows the kind of nailing-on apparatus most familiar in cotton mills, and is made by Dronsfield Bros. of Oldham.

The card mounter is fixed on the card framing in front of cylinder or doffer, F, as shown in the sketch. It consists of a bed, K, upon which slides the mounting head, H, which is traversed by the screw to which the chain wheel, L, is fastened, or by the handle, M. The latter is used when it is required to traverse the head quickly by hand. The mounting head consists of a feed box, D, through which the fillet is guided to a cone drum divided into three sections of different diameters. In front of the drum is a curved plate which shunts the fillet from one section of the drum to the other. The fillet passes from the feed box to the first step of the cone which is the smallest in diameter, then round the curved plate to the second step, and so on to the final step of the cone, which is the largest in diameter. This last step being covered with leather, the fillet cannot slip over it; but as it is larger in diameter it requires more fillet to go round it, and a certain amount of tension is put on the fillet by slipping over the two first steps. Any further required tension may be put on by screwing down the weight on the feed box, or by putting brake on the shaft of the cone drum. From the last step of the cone the fillet passes to the lever, E, whence it passes direct to the cylinder or doffer. This lever also actuates the finger which indicates the exact tension obtained, and is very sensitive. The rest and tool for turning up wood rollers, etc., is arranged to slide on the same bed, K, the mounting head being removed.

The double purchase jack, U, which is actuated by the handle, R, is fixed on the cylinder or doffer shaft, and is screwed thereto by a screw and die which increases its hold on the shaft as the tension on the card fillet is increased. It is fitted with two fixed chain wheels for 1½ in. and 2 in. fillets, so that it is only necessary to slip the chain from one wheel to the other when changing the feed from cylinder to doffer fillets or *vice versâ*.

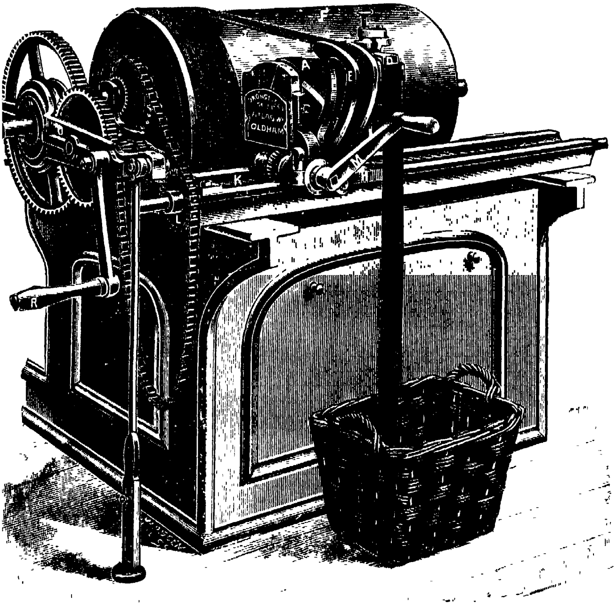

FIG. 6 (*a*).—Patent Card-mounting Machine, with new Patent Tension Indicator.

The following is the amount of tension which has been recommended :—

Cylinder fillets, mild steel wire . .	about	230 lb.
If hardened and tempered steel . .	,,	325 ,,
Doffer fillet, if mild steel wire . .	,,	160 ,,
If hardened and tempered steel . .	,,	225 ,,
Roller fillet, 1 in. wide	,,	120 ,,

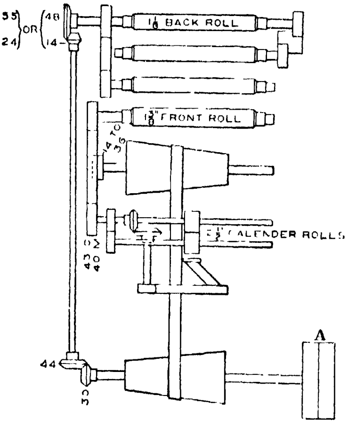

FIG. 6 (*b*).—Diagram of Gearing of Coiler Railway Head.

Railway Head.

What is termed the "railway head" appears to have received a good deal of adoption in the United States of America, and is still in use in many mills there, although, so far as the author can judge, its use is being diminished in favour of the English system. The railway head contains an application of the cone drum regulating motion to what might be termed the first head or carding head of drawframe. The illustration (Fig. 6 (*b*)), shows the gearing plan and driving arrangement of a well-known American make of coiler railway head.

This coiler head is to be used in connection with cards, delivering into coiler cans. It takes the place of the first process or head of drawing, and it is contended that it gives a more even sliver as the basis of subsequent operations. Motion is received from the driving shaft to the pulleys at A, and the various parts of the frame are driven from the bottom cone shaft as shown. The principle of the motion is that the draft may be automatically regulated by the cone drums according to the thickness of the combined slivers.

While the back roller is driven at a constant speed the front roller is driven faster when the cotton is thicker, and slower when the cotton is thinner. In some cases the railway head has been coupled up to the carding engines in such a manner that several cards have fed one railway head.

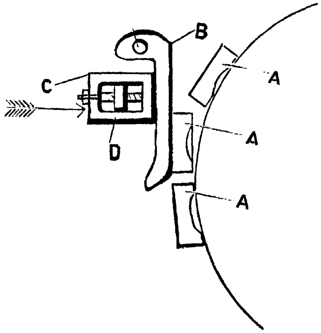

FIG. 7.

PATENT FLAT MOTIONS.

No practical man will deny the importance of keeping the wires on the flats of a revolving flat card in good condition, and anything which prevents the wires being broken out of the flat, or the bend being taken out of the wires, should be at least worthy of consideration by all practical men.

The flat stripping is a source of anxiety to all carders, especially where the revolving flat cards are a few years old. It is found that all the flats are not presented to the comb in the same relative position, this being due to various causes, chief amongst them being the elongation of the flat chain, and also by waste getting between the flats and the front disc or plate wheel, and, consequently, if the comb is set to one flat, that is, in the correct position on the disc, it will come into contact with the wires of those flats which, from the causes mentioned, are allowed to stand farther away from the disc, thus either taking the bend out of the wires or breaking the wires out of the flat, and, in either case, the power of the card to produce good carding is considerably diminished.

Amongst the various devices which have been invented to cope with this evil is one patented by Messrs. Gillett & Fogg, of Chorley, of which the following is a short description:—

Referring to Fig. 7, A, A, A are the flats; B a slide which slides against the ends of the flats; C is a small block in which the comb is made adjustable; D is the end of the comb. The comb instead of being held rigidly upon the arms is allowed to move backwards and forwards upon the arms. A spring presses the comb in the direction of the arrow, bringing the block against the slide and the slide against the flat ends, and the comb in its up and down motion is kept in a line parallel to the wires of the flat, no matter what position the flat assumes, and the comb, after being adjusted once in the block (which is provided with adjusting screws), is kept at the same distance from the wires of every flat, no matter whether the flat lies close to the disc, or is pushed away by waste, or allowed to fall away by the elongation of the chain.

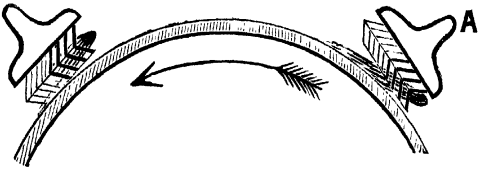

FIG. 7 (a).

Another of the new motions for stripping the flats is discussed in the section on carding in the first volume.

PATENT DOUBLE-CURVE FLEXIBLE BEND.

An interesting improvement in the revolving flat card has been patented by Messrs. Gillett, Fogg & Thompson, in which the principle by which the flats manipulate the cotton has been entirely changed. The flat is made to take hold of the cotton in its entangled form, and to give it to the cylinder again in such a manner that the operation may be said to resemble to some extent the operation of the comber. By this improved method a large amount of dead and short cotton is left in the flat, and the long fibres are placed again on the cylinder in a more parallel condition. In Fig. 7 (*a*) A is the flat nearest the taker-in, and the other flat is nearest the doffer.

Referring to the sketch, it will be seen that at the back of the card the flats are presented to the cylinder with their toe nearest to the cylinder, the flats are clothed with wire clothing, which is composed of two counts of wire. The wires at the toe are of coarser counts (less points in a given space), thicker and therefore stronger wires, and they are given a more acute bend; in fact, they are bent to an angle of something like 50° from the foundation. The counts of the wire at the heel of the flat are fine, the bend about 70°, and the wire thinner.

The object is to put the entangled cotton into the wires at the toe of the flat without breaking it up, and then to turn the flat gradually over, and draw the long fibres out of the entanglement, leaving dirt, dead and short cotton in the wires at the toe of the flat. It may be mentioned that the fine wires at the heel of the flat are preserved in a clean condition until they come into contact with the cotton at the front of the card.

The strips from this flat are quite different to the strips from an ordinary flat; the dead cotton and dirt being present at the toe part of the strips, giving them quite a different appearance: the fibres are more parallel; and yarn produced from it is stronger and more compact.

It may be mentioned that everything about the working of these flats is quite simple; the same flats and flexibles are used with some slight alterations. This is a most important and novel departure in the construction of a revolving flat card, but a more extended trial is necessary to prove its superiority over the ordinary card.

Q. 1901. Assuming that you have just completely overhauled, re-clothed and ground a revolving flat carding engine, how would you proceed to adjust the various working parts, and in what order? What precautions would you take before again commencing work?

A. We may begin with the feed part of the card, and we may set the feed plate, say, to $\frac{7}{1000}$ in. from the licker-in, taking every precaution to set these and other parts parallel to each other. As a basis we may take American cotton for medium counts of yarn, with the lap from the finisher scutcher weighing, say, about 13 oz. per yard. The gauge should be capable of being drawn along quite freely, although an equal pressure should be felt on it all across, and care should be taken not to have the gauge passing between the licker-in and mote knife when setting the feed plate. We may use the same gauge when setting the licker-in to the cylinder, first having the bolts in the licker-in pedestals slackened, and afterwards taking the precaution to screw these up well, or else the belts will pull the licker-in against the cylinder wire. Generally speaking, it might be considered good practice to set the licker-in undercasing as close to the licker-in as it conveniently can be in order to prevent the emission of fibre.

It is as well to remember that the angle of the mote knives is of great importance as well as their distance from the licker-in.

Having finished with the feed parts of the card, the flats may next be adjusted, although perhaps some would prefer to set the flats first.

On many cards, at least when it is required to set the flats, it is necessary to take off the worm pulley to permit of the flats being turned round by hand by means of a handle or key placed upon the specially prepared end of the worm shaft.

Having selected a setting flat, we may take out a flat or two on either side of it.

Assuming three setting places with two supports between the setting screws, the supports are moved out of the way, and the setting flat is worked round by means of the handle to the first setting point. Here adjustments are made to, say, a gauge of $\frac{10}{1000}$ in.

The same procedure may be adopted with the other setting points working from back to front of the card, and afterwards going over the work from front again, as altering one setting point is apt to affect the setting at another point somewhat. Afterwards the two side supports on each side of the card should be brought up to just nicely touch the flexibles, and the flats replaced that had been taken out beside the setting flat.

Coming now to the doffer, this should be set as close as possible without touching, say, to a gauge of $\frac{5}{1000}$ in. if convenient.

The doffer comb need not be set as close as this.

The cylinder undercasing may be set wide at the front—say, easy to several gauges' thickness put together—but it should be a good deal closer at the back.

Before recommencing work every precaution should be taken to ensure that none of the wires are rubbing, a good plan being to turn the cylinder and doffer by hand with the engine stopped, meantime carefully listening.

Care should be taken also to have all the parts well screwed up, and to have all the bearings well oiled and all belts and cords replaced.

COMBING.

Q. 1898. What parts of a Heilman combing machine would you have to adjust if, after combing Egyptian cotton, you proceeded to comb a good quality of Sea Islands?

A. We have known Sea Islands and Egyptian cotton to be both advantageously worked on the comber with the same setting and timing, but should not care to try this for moderate Egyptian and long Sea Islands cottons. The distance between the flutes of the bottom feed rollers and those of the long steel detaching roller may be $1\frac{13}{16}$ inch for Egyptian cotton, while $\frac{1}{4}$ inch ought to be added to this for long Sea Islands, giving the distance as $2\frac{1}{16}$ inches. The distance between the flutes of the long steel detaching roller—an important setting point—and the front edge of cushion plate, or bottom nipper, may be $1\frac{3}{16}$ inch for Egyptian and $1\frac{7}{16}$ inch for long Sea Islands.

The nippers may be set to the cylinder needles and the top combs to the cylinder segment, with a 19's gauge for Egyptian and a 21's for Sea Islands. We may have detaching roller forward, and nip about one tooth of the index wheel later for Sea Islands. Other settings and timings differ little, if any, for the two cottons, and the remarks made apply about equally well to single and duplex combers.

Q. 1897. How would you proceed to set the various parts of a single nip Heilman combing machine relatively to one another when combing Florida Sea Islands cotton?

A. The timing and setting of a combing machine are of the utmost importance in any case, and are affected somewhat by the following considerations: The amount of waste to be taken out, the length of staple and the weight of lap operated upon. In setting, certain gauges of special construction have to be used, and very great assistance is rendered in timing and setting by a special index wheel fixed on the cylinder shaft at the end of the machine. This wheel contains eighty teeth as the standard, and is divided and marked out in twenty portions of four teeth each, with a special pointer to show the positions accurately. This method of division provides that one tooth is a quarter of a mark, two teeth a half, and, of course, three teeth three-quarters of a mark, without any necessity for these sub divisions being marked on the face of the index wheel. The timing and setting of a comber bear a strong analogy to the timing and setting of a loom or mule, in the importance of their effect upon the correct working of the machine; but the difficulty of adjustment on a comber is greatly minimised as compared to the other machines by the provision of this index wheel. Loom overlookers would doubtless more readily acquire facility in making correct adjustments if they had an index wheel marked out in this fashion, and instructions were given to them to get the shedding to commence at $4\frac{1}{2}$ and the picking at 6, and the beating up to $10\frac{1}{4}$, etc. Similarly mule overlookers would not be liable to get far wrong if they had to set the backing-off friction to engage at $7\frac{1}{2}$, the fallers to lock at $8\frac{3}{4}$, etc. We put it this way because this is largely what is the case with the comber by the provision of the index wheel just explained. The feed rollers for long Sea Islands might be set $2\frac{1}{16}$ inch from long steel detaching roller, the latter being an important setting point, although in this respect being probably second to the cylinder. With the index wheel at about 5 we might have $1\frac{1}{8}$ inch gauge between front edge of fluted segment on the cylinder and long steel detaching roller, and we might have a 22's gauge between flutes of the same fluted segment and the flutes of the long steel detaching roller. The nippers ought to have a sheet of writing paper to bite equally and firmly between them, and there may be a $1\frac{7}{16}$ inch gauge used between front edge of cushion plate and long steel detaching roller for long Sea Islands cotton, and the nipper knife might be set with about a 21's gauge between it and the needles of the cylinder. As regards the leather detaching rollers, we might set them to have a piece of writing paper between the flats of their brass ends and the lifters, when the latter are in their lowest position, and the leather rollers are resting on the fluted segment of the cylinder. The top combs may be set to have a 19's gauge between them and the cylinder fluted segment, and to about 14's angle. As regards timing, the feed rollers might be set to move at about 5, the detaching roller about 6, the top comb to be down $5\frac{1}{2}$, the nippers to close about $9\frac{1}{4}$, and the clutch wheel (Messrs. Dobson's new comber) to be in gear at about $\frac{3}{4}$, all these, of course, being approximate timings. For Egyptian cotton the above settings would also largely hold good, the chief exceptions being that the distance between flutes of detaching and feed rollers would be reduced to $1\frac{13}{16}$ inch, and the distance between flutes of detaching roller and front edge of cushion plate would be reduced to $1\frac{3}{16}$ inch.

Q. 1901. You are watching the operation of a combing machine, and you notice that the sliver as delivered is cloudy or curled. To what causes would you attribute these defects, and how would you remedy them?

A. Curliness of the fine web delivered by a comber head is of very frequent occurrence, and is sometimes difficult to remedy.

A very common cause is not having the short top fluted piecing roller parallel with the other two detaching rollers. This roller can be very readily disturbed from a parallel condition owing to the method of sustaining it. The intermittent action of the machine and carelessness of tentors may lead to its disarrangement. Very dry weather sometimes leads to the evils specified, and recourse in such cases may be had to the degging can.

Curling is very frequently caused by defects in connection with the leather-covered detaching rollers, such as being short of lubrication, badly covered with leather, and not being properly set and timed. The remedies in such cases are obvious. Cloudiness of the fine fleece may be caused by unlevel setting or covering of the nippers. If the nippers do not hold the cotton firmly all across, the fibres are liable to be pulled from the nippers in tufts. Dirty cylinders and flocking should be guarded against to prevent cloudiness of the web.

DRAWFRAMES.

Q. 1896. How would you set the rollers of a drawing frame if you were drawing slivers made from either good Dhollerah, Texas, Brown Egyptian or Sea Islands cotton? How would you arrange the drafts in each passage?

A. There are several fundamental principles which chiefly regulate the distance apart of the drawing or "draft" rollers in a spinning mill; (1) The distance from centre to centre of front and second rollers should always slightly exceed the length of the cotton fibres, say by $\frac{1}{32}$ of an inch. This applies more particularly to the front and middle rollers of the mule or ring frame. (2) When there is a very small draft the rollers can be farther apart, as between the back and middle rollers of the various machines. (3) The thicker the body of fibres operated upon, the farther apart should the rollers be. Because of this the rollers in the card-room are set a greater distance from centre to centre of adjoining rollers than the corresponding rollers in the spinning-room. The greater diameter of the rollers to some extent compels this. Coming, then, more particularly to the drawframe, for good Dhollerah we might have the first, third and fourth rollers $1\frac{1}{8}$ inch diameter, and the second roller 1 inch diameter. A good working distance between the leathers of the first and second rollers would be $\frac{1}{16}$ of an inch or so, and between the other lines of rollers we might have the same or a little greater distance. The total draft would be about six, as doubtless six ends would be put up together. This total draft might be split up as follows: Between first and second rollers, 2·86; between second and third, 1·71; and between the third and back rollers, 1·22.

Proof:—

$$\frac{6 \text{ total draft}}{1{\cdot}71 \times 2{\cdot}86} = 1{\cdot}22.$$

For American cotton, such as Texas, it is usual to have the rollers larger in diameter than as given above for Indian. Common dimensions are $1\frac{3}{8}$ inch diameter for first, third and fourth iron rollers, and $1\frac{1}{8}$ inch for second roller. Something a little more or less than $\frac{1}{16}$ of an inch space might be allowed between the various lines of rollers, the wider distances being usually reserved for the back rollers. The drafts for Texas might be as given for Dhollerah, or a little varied therefrom. In many cases the rollers are $\frac{1}{8}$ inch less diameter that as above given for American.

For Egyptian and Sea Islands we could have the diameters of the rollers as given for American, or, say, $1\frac{1}{2}$ inch for the first, third and fourth rollers, and $1\frac{1}{4}$ inch for second roller. There might be a space of $\frac{1}{16}$ to $\frac{1}{8}$ of an inch or more between the various lines of rollers, according to the diameters of the rollers and the length of the cotton. If six ends were doubled the drafts might be as given above for Indian and American. If eight ends were doubled the drafts might approximate to the following: 3·12 between first and second lines, 1·95 between second and third lines, and 1·31 between third and fourth lines.

Proof:—

$$\frac{8 \text{ total draft}}{3{\cdot}12 \times 1{\cdot}95} = 1{\cdot}31.$$

The drafts for all these cottons might be the same in each of the three heads of drawing usually employed.

It may be added that an approximately correct *rule for apportioning the drafts* of a draw frame is as follows: (1) For the middle draft of the three, extract the cube root of the total draft. (2) Extract the square root of the middle draft thus found for the back draft. (3) Divide the product of the two drafts thus found *into* the total draft in order to find the front or delivery draft.

For example, take a case where eight slivers are doubled together and a total draft of eight is required;—

$$(1)\ \sqrt[3]{8} = 2 = \text{middle draft.}$$

$$(2)\ \sqrt{2} = 1{\cdot}4 = \text{back draft.}$$

$$(3)\ \frac{8}{1{\cdot}4 \times 2} = 2{\cdot}86 \text{ front draft.}$$

Q. 1900. The slivers from a finishing drawframe are found to be very uneven in weight at irregular intervals. What, in your opinion, is the reason for this, and how can it best be prevented? What happens if the cotton used is uneven in length?

A. The first thing to inquire into is the uniformity of the laps from the finisher scutcher, both as regards weight of full laps and weight yard per yard of the lap. If this is found to be sufficiently wrong it will be requisite to trace the cause. Very probably this will be found in something belonging to the piano feed regulator, such as dirtiness of the parts, something having worked loose, or slackness and slipping of the cone drum belt.

It may be caused by the scutcher feed motion, or possibly by the opener feed regulator.

Again, such unevenness has often been traced back to the hopper feed.

Providing the lap is right when it leaves the finisher, it is probable that the sliver will reach the drawframe in a sufficiently uniform condition to make us conclude that the irregularity is caused in the drawframe itself, although it is sometimes caused at the comber when the latter is used. At the drawframe a great cause of irregular work is the imperfect action of the stop motion, and the various parts should all be tested and carefully watched to detect such imperfect action. Sometimes irregularities can be traced to defects in connection with the drawing rollers.

If uneven work passes forward beyond the drawframe it is almost certain to give yarn that is irregular in counts. When the cotton is uneven in length it is difficult to get uniform drawing, because the rollers cannot be set to the best advantage for both long and short fibres at the same time. There is a tendency for the short fibres to come out in bunches, and to leave correspondingly thin places of sliver elsewhere.

Q. 1898. If you were spinning 40's twist yarn and you were asked to spin 24's hosiery, what changes would you make in the setting and working of the drawing and roving frames?

A. If this change were to be of some permanence it is possible that the quality of cotton would be altered. Supposing cotton of shorter staple be used, then the rollers of the drawing and roving frames should be set closer together if at all convenient. In many cases of small orders it is quite probable that nothing but the mule or ring-frame would be altered, the various adjustments of twist, counts, etc., being made at the proper places of the final spinning machine. In many cases the cotton might remain the same and the alterations divided out between the drawing frames, bobbin and fly frames, and final spinning machine. Assuming this to be the case, the change pinion for counts on the drawing frame would require proper alteration, say a larger wheel in proportion to the amount of increased thickness of sliver required at this point. At the roving frame several wheels would require to be altered according to well-known rules. The change pinion for counts or hank roving would require making larger in simple proportion to the increase in thickness of the roving. The ratchet or rack wheel would require to be made smaller, while the twist wheel and the lifter wheel or strike wheel would require to be made larger, all three in proportion to the square roots of the rovings previously making and those intending to make. 24's hosiery would probably require to be of good quality spun from very fair cotton, and because of its soft, clean character the twist would require to be kept down as much as possible, and every care should be exercised to keep the rovings free from motes or slubs, as these are fatal to the processes of hosiery manufacture.

Q. 1897. If you had drawing frames constructed and arranged for the preparation of slivers for 80's Egyptian yarn, state fully what changes you would make in adapting them to draw slivers prepared from Broach cotton for 20's yarn. How would you set the rollers? Give briefly your reasons.

A. If eight ends were being put up together for the 80's Egyptian—as is often the case with these yarns—it is very probable that we should make two of the back spoons used for slivers going to each front delivery inoperative. In which case corresponding alterations would have to be made in the traverse guide. If this course were adopted the draft would have to be diminished from about eight to about six. In some instances the full can knocking off motion has a change wheel used in connection with it, and in such cases this wheel would have to be regulated in size according to the change made in the thickness of the sliver. If the diameter of the sliver were varied considerably, then it is not unlikely that the size of aperture in the front trumpet tube would have to be altered in proportion. Perhaps the most important point to attend to would be the adoption of means by which the rollers could be got sufficiently close to accommodate the length of fibre. It is common to make the rollers much

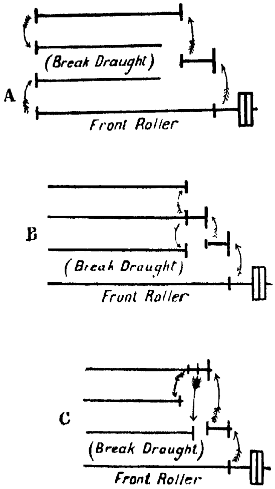

FIG. 8.

larger in diameter for Egyptian than for Indian cotton—say, for instance, $1\frac{1}{8}$ inch diameter for front iron roller, and 1 inch diameter for middle roller with Indian cotton, and $1\frac{1}{2}$ inch and $1\frac{1}{4}$ inch diameter respectively for Egyptian. To get the best results, therefore, we should require new top and bottom drawing rollers. The weights on the rollers could conveniently be altered with lever weighting, but with dead weights it is a question as to whether it would pay to get new weights for the slight amount heavier which it is usual to allow for the Indian.

Driving of Drawing-Frame Rollers.

In an ordinary cotton spinning mill without combing all the machines contain three pairs of drawing rollers, except the drawframe, in which there are four pairs. Having four pairs of rollers on a drawframe somewhat complicates the driving, and there are several methods more or less in use. Probably the most common arrangement is the one shown at C (Fig. 8).

Messrs. Howard & Bullough, for instance, make any one of the three methods shown in Fig. 8, according to requirements. Usually the break draft is between the first and second rollers, as at B, C, but in the case of A this draft is between the second and third rollers. Having the wheels that drive the intermediate rollers on the opposite side to the driving pulleys, as shown at A, is considered by some to be the most convenient method. The arrows in each case indicate the transmission of power from one roller to another, and it will be noticed that while at C the driving is direct to the back roller from the front row, at B the third roller drives the fourth or back roller. The break draft is that which is altered when we put on a different size of change wheel for draft.

Q. Having three heads of drawing, six ends up at each, making finished sliver about 15 dwts. for six yards, and with drafts as under—

	Card box.	Middle box.	Finisher box.
Between front and second roller	2·3	1·7	3·5
,, second and third ,,	1·8	1·8	1·3
,, third and fourth ,,	2·1	1·7	1·1

how would you arrange the drafts to ensure more easy drawing and better results, while still retaining the same weight per yard of finished stuff from the same card stuff?

A. An essential condition of this problem is that the final product of all the three total drafts shall be the same after the rearrangement as before.

It is required to proportion out the three total drafts and all the intermediate drafts in a manner calculated to give better working results. At present we have :—

2·1 × 1·8 × 2·3 = 8·69 = total draft at the card box.
1·7 × 1·8 × 1·7 = 5·20 = „ „ „ middle box.
1·1 × 1·3 × 3·5 = 5·00 = „ „ „ finisher box.

The product of these three total drafts will therefore be—

8·69 × 5·20 × 5·00 = 226.

While the final product is suitable for actual working, it is at once evident that the three total drafts are quite wrong, as they should be practically alike.

At the same time the middle drafts are very badly proportioned, except in the finisher box, where a little more draft at the back and second from back positions would have given good results.

In many cases the draft in each head of drawing is kept the same, and we might extract the cube root of 226 to find what this should be, or we might find suitable drafts by trial, thus—

6·1 × 6·1 × 6·1 = 226·98.

These will therefore do very nicely.

An approximately correct rule for proportioning the total draft of a drawframe is given a few pages earlier in this treatise: but it will be quite convenient to simply take the finisher box as given, and slightly modify the decimal points according to the teachings of practical experience:—

Back. Middle. Front.
Thus, card box, 1·2 × 1·6 × 3·2 = 6·144.
„ middle box, 1·2 × 1·6 × 3·2 = 6·144.
„ back box, 1·2 × 1·6 × 3·2 = 6·144.

The final product of these three total drafts will be just a few decimals higher than what is required, but should be sufficiently near.

FLY FRAMES.

Q. 1898. Suppose that in building a roving bobbin you found the coils were being laid too widely apart,[1] what course would you take to correct the fault?

A. As far as it goes this question appears to the mind of the author as a typical and practical question, such as ought to find as much prominence as possible, both in teaching and in the examination papers, as it is the kind of thing we have to deal with in actual practice. In the opinion of the author, no student who cannot answer this question correctly is worthy of a first honours, no matter what else he may know. If the coils were being laid too widely apart, then, evidently, the speed of the top rail or lifter would require to be reduced to the required degree, the rate of delivery and the winding-on of the roving remaining the same. In some cases this would be accomplished by putting on a less strike wheel, while in other cases a wheel belonging to the short lifter shaft train of wheels at the end of the frame would be changed. In some cases it would be possible to alter another wheel nearer to the cone drum than the small strike wheel for driving the reversing bevels. The question only calls for a short answer.

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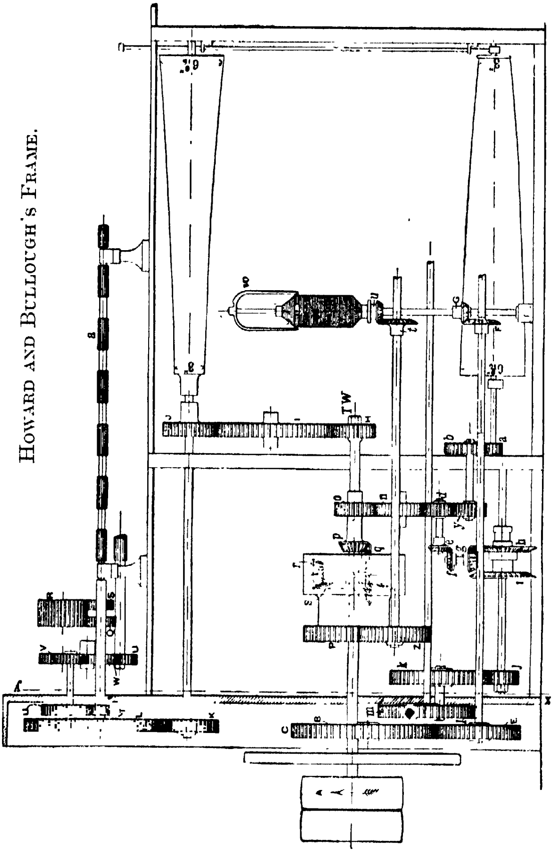
[1] See also page 70.

Q. 1896. What parts of a roving frame are, directly or indirectly, driven from the twist wheel, and how are they affected by a change of that wheel?

A. The twist wheel is by far the most important wheel about the frame. It is fixed on the inner end of the jack shaft, or main shaft of the frame, and, with the exception of the spindles, it is connected more or less to every motion about the machine. It drives the top cone drum shaft, and from the end of this latter shaft is connected a train of wheels by which the drawing rollers are driven. Through the medium of the cone drums it is connected to the lifter and differential motion. If it were pulled off and the frame started the rollers and the lifter would stop, the spindles would go on as usual, and the bobbins would keep on revolving; but in a bobbin leading frame they would revolve at a reduced rate, so that no winding could take place. The chief duty of the twist wheel, of course, is to regulate the twist. This is done by putting a smaller wheel on when more twist is required, as when going on finer counts of roving. This smaller wheel drives the rollers more slowly, and allows the spindles to revolve at the same rate as previously, so that the same revolutions of spindle are made to a less delivery of roving, which, of course, means more twist per inch. A larger twist wheel puts less twist in by causing more material to issue from the rollers to a fixed number of revolutions of the spindles. It is not so easy to see the exact effect of a change in size of twist wheel upon the lifter speed and the differential motion. Suppose we change to a finer hank roving, and we put a less twist wheel on, what effect will it have on the lifter and on the sun wheel? As regards the lifter, it is made to go more slowly by a less twist wheel being put on, and the author has known many carders to imagine that no further attention need be paid to the lifter speed. This may do for a small change, but not for a change of any magnitude. In this case the less twist wheel slowers the lift so much as to compensate for the slower rate at which the rollers deliver the roving. But this does not meet the case. The lifter, in addition, requires to be traversed more slowly to compensate for the roving being thinner, with which effect the twist wheel has nothing to do; as the lifter wheel is usually a driver, it follows that a less lifter wheel should be put on for finer counts as well as a less twist wheel. Take now the connection of the twist wheel to the sun wheel, and consequently to the bobbins. In changing to finer hank roving the less twist wheel put on will cause the sun wheel to revolve more slowly, which means that the bobbins will revolve more slowly in a bobbin leading frame, and more quickly in a flyer leading frame. In either case compensation is made in the winding for the reduced rate at which the roving issues from the rollers, and this does all that is required until the completion of the first layer. Immediately the first layer is deposited upon the bobbin it is necessary all through the set afterwards to make compensation in the winding for the thinner nature of the roving, as well as its slower rate of delivery by the rollers. As every layer of roving put on the bobbin is thinner than when on the former hank roving it is necessary to ease the winding to a less degree than formerly at every change. This second effect is produced by a change in the size of the ratchet wheel. A larger ratchet wheel is put on, that is to say, a wheel that is the same diameter, but it contains more teeth. As a consequence the teeth are less, and each change now moves the cone strap to a less degree than formerly up the bottom cone.

Fig. 9 gives a general view of a fly frame as made by Messrs. Howard & Bullough. It will be noticed that the twist wheel, T, W, at the inside extremity of the pulley shaft, drives almost all parts of the frame, either directly or indirectly. The gearing plan of a slubbing frame as made by Messrs. Hetherington is also given in Fig. 9 (*a*).

Q. 1900. Describe the construction of any differential motion of a roving frame you are acquainted with.

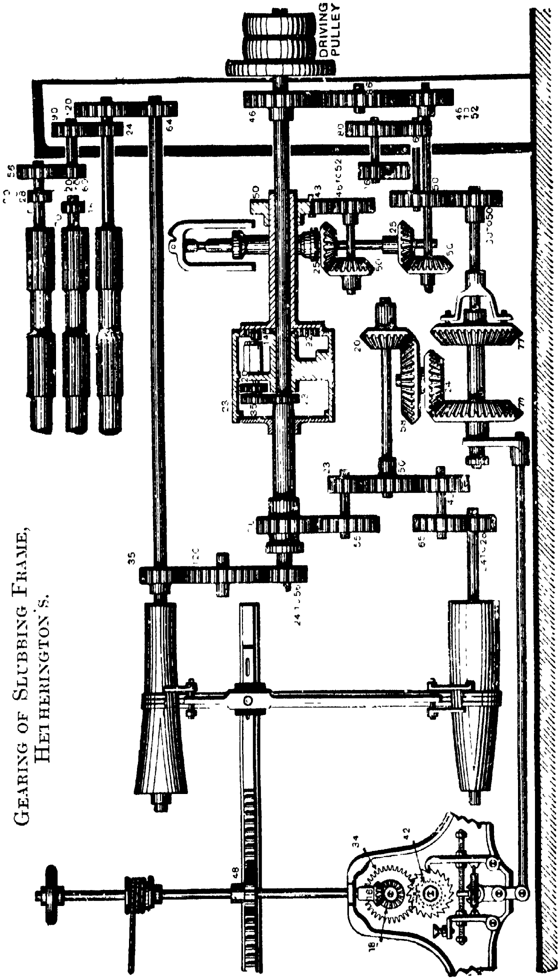


HOWARD AND BULLOUGH'S FRAME.

'SPEED' FRAMES

FIG. 9.

Say what would be the practical effect if the strain on the cone strap was so excessive as to cause it



GEARING OF SLUBBING FRAME, HETHERINGTON'S.

FIG. 9 (*a*)

(a) to slip or (b) not to advance when the traverse was changed. If you know of any means by which either of these faults can be prevented, describe it.

A. Holdsworth's differential motion is the oldest and best known form. In this there are five wheels, four of which are bevel wheels of equal size gearing into each other. The fifth wheel is the sun wheel. One of the four bevels is the main driver of the bobbins, and if the sun wheel were stopped it would rotate the bobbins at the same speed as the spindles. Two of the bevels are carried by the sun wheel, and are carrier wheels, of which one is only a balance to the other, and could be dispensed with. The other bevel is the driven wheel of the series, and is compounded with the first wheel of the "swing motion". The action of the sun wheel and carriers is such that in a bobbin leading frame every time the sun wheel makes one revolution two revolutions are given to the bobbin wheel in addition to those obtained from the main driving.

If the cone belt slipped, the ends would run slack, because the sun wheel would run too slow, and therefore so also would the bobbins.

If the cone belt did not advance properly it would tend to stretch the ends in proportion to the amount of the delay of the belt. Various devices have been brought out with a view to preventing or minimising such defects as the above. The most important is the great adoption of improved differential motions, which impose less work on the cone belt.

In some cases duplex cones are adopted, and in others divided belts for the purpose of reducing such evils as the above.

HOLDSWORTH'S MOTION.

It may be well to add here an extended description of Holdsworth's motion, and follow with one of the newer motions. It must be borne in mind that the power to drive all the parts of the machine is derived from its main shaft, which has a uniform and constant revolution. Referring to Fig. 10, a proper train of wheels drives the drawing rollers at a uniform speed; another train drives the spindles also uniformly from the wheel P upon the main shaft, M. These are what we may term the constants. We may now get at the variants, the bobbin and the mechanism which drives it. Power is taken from the main shaft through the wheel Q to the top cone drum, one of a pair, by the use of which the variant capability is brought in. From the top cone drum power is transmitted by means of a strap to the bottom cone, upon the axle or shaft of which is fixed a small pinion wheel, R, gearing into the sun wheel, N. Upon the wheel N two lugs are cast to form bearing for the wheels L, L_1, through the first of which the power is transmitted to the wheel O, whilst L_1 is an idle or at most a balance wheel. The bevel wheel, K, is the main driver of the arrangement. Being fixed to the shaft and revolving with it in the direction indicated, it turns the wheel L, as marked, this again causing the bevel to which the wheel O is cast to revolve in the direction shown, which, it will be observed, is opposite to the revolution of the main shaft. The wheel N, and those connected with it, are necessarily loose upon the shaft, M, to admit of their revolution and variable movement in the opposite direction. If the bottom cone pinion, R, was not moving, the rate of revolution transmitted from the bevel, K, through the wheel, L, to the bevel attached to the wheel O would be exactly equal to that of the shaft, M, upon which it is fixed. Thus the wheel O driving the bobbins would revolve at the same rate as the wheel, P, driving the spindles; only the revolution of the two wheels would be in opposite directions, and spindles and bobbins, as a consequence, would revolve exactly at the same rate, in which state no winding could take place. The power to diminish or accelerate the rate of revolution is derived, as we have traced, from the cones. As the wheel N, driven by the cone pinion, R, revolves in the direction of its arrow, the speed of the wheel L and its

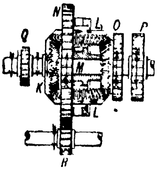


Fig. 10

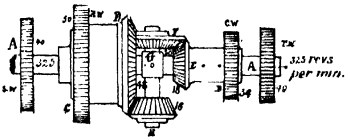


Fig. 11.

connection, the wheel O, are accelerated in exact ratio; and thus the excess speed of the bobbin over the spindle is obtained. At the commencement of a set the bobbin must run at its maximum rate, and the machine therefore begins its work with the cone strap upon the largest diameter of the driving cone and upon the smallest of the driven cones. With the deposit of every layer of rove upon the bobbin the strap is traversed a little distance from the largest diameter of the top cone and each successive change until, with the full bobbin, the minimum diameter is reached, giving the minimum rate of revolution to the bobbin.

A chief defect referred to above will now be easy to discover. It lies in the fact that the whole of the differential mechanism revolves in a direction opposite to that of the shaft, M, upon which it is carried, at any rate with a bobbin-leading frame.

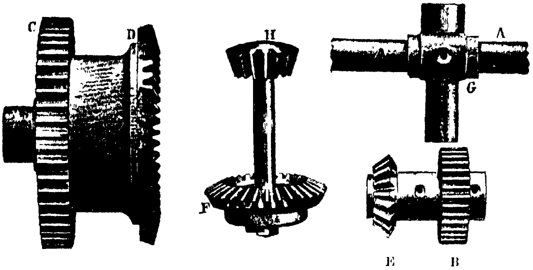


Fig. 12.

Messrs. Howard & Bullough's Motion.[1]

Messrs. Howard & Bullough have effected considerable modifications in the construction of the apparatus, as will be evident from the following description. On the main shaft, A (Figs. 11 and 12), is cast a boss or cross piece, G, for the reception of, and to form a bearing for, the small cross shaft carrying the bevel wheels, F, H. Loose on the shaft, A, is the bell, or, as it is sometimes called, the socket wheel, C, which through its connections drives the bobbins. Attached to the wheel C is the bevel wheel, D. Beyond the cross shaft, and loose upon the main shaft, is the wheel, B, in connection with the lower cone drum; upon the extended boss of this wheel is cast the bevel wheel, E, which gears into the bevel, F. These constitute the parts of the new arrangement, the action of which is as follows: The shaft, A, revolves round, carrying the boss, G, and the cross shaft around with it. If no disturbing factor interfered all the wheels geared together would, as we have also seen in the old arrangement, revolve together, and no winding would take place, as the speed of the bobbins would be the same as that of the spindles. In this case, however, it is necessary to note that the revolutions of the various wheels are all in one direction, and thus entail little expenditure of power beyond that required to overcome the inertia of the various parts of the machine and to maintain them in motion. It will thus be seen that the chief defect of the old arrangement is much diminished, *viz.*, the great waste of power and the strain upon the working parts, and especially upon the cone strap. We now, however, want the winding to be performed, and in order to do this the bobbins must revolve as before, faster than the spindles. As in the previous case, the differential power is obtained from the cone drums, the bottom one of which through its connections drives the wheel, B, which through its attached bevel, E, working into the bevel, F, on the cross shaft by means of the small bevel, H, on its opposite extremity, accelerates through the bevel wheel, D, the bell wheel, C, driving the bobbins. This acceleration is to the extent of the motion it drives from the cones. With the commencement of a set, of course, the bobbin starts at its maximum rate of revolution, whilst its rate is diminished by the shifting of the cone strap in the usual way. It will be seen that in this arrangement the revolution of the shaft, A, becomes a help to the cone strap instead of a hindrance and an obstacle, as in the older form. This motion is the invention of Mr. Tweedale.

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[1] Fig. 11 shows this motion as it works on the machine, while Fig. 12 shows the various component parts in detail. The letters are the same in each case.

It may be added that several other excellent patented differential motions are on the market, and have received extensive and successful adoption.

Calculations on Tweedale's Motion.

It may be said that if the cone wheel, B, went just the same speed as the shaft, the cross shaft bevels, H, F, would have no axial motion.

The wheels, H, F, have their maximum axial motion when the cone wheel is stopped, owing to the cone belt being slackened for doffing or other purposes.

When working there are three distinct actions taking place: (1) H acts as a clutch with D, and endeavours to take D round this way as fast as the shaft. (2) F rolls round E, and in this way the cross bevels, H, F, are made to rotate on their own axis. (3) The cone wheel, B, E, in its revolution also endeavours to revolve the cross bevels and shaft, but in the opposite direction to that obtained from the direct rotation of the pulley shaft.

The second motion goes to negative the first motion, and the third or cone motion goes to negative the second, so that the first and third motions assist each other.

Taking the sizes as given on the sketch—

$$\frac{\text{S, W}}{\text{B, W}} = \frac{40}{50} = \frac{4}{5},$$

or a difference of one-fifth in size between the two.

There is the same proportion between the carrier wheels

$$\therefore \frac{E \times H}{F \times D} = \frac{18 \times 16}{30 \times 48} = \frac{1}{5}.$$

In actual mill practice the manager or carder sometimes desires to ascertain the revolutions per minute of the bobbin wheel, C or B, W. When this is done, it is only a case of simple speeds to find the revolutions per minute of the bobbins and, from the diameters of the bobbins, the inches wound on.

Rules.—(1) If the cone wheel revolve faster than the shaft, then we may take it that the revolutions of B, W would equal those of the pulley shaft, *plus* one for every five revolutions gained by the cone wheel on the shaft.

(2) Suppose, on the other hand, the cone wheel revolve slower than the shaft, then from the speed of the shaft subtract one for every five lost by the cone wheel.

Every practical man should be easily able to act according to these rules, and the answer in each case will be the revolutions per minute of the bobbin wheel, B, W.

Examples.—Ascertain the revolutions per minute of the B, W, with frame shaft at 325 revolutions per minute, and cone, W, making the following revolutions per minute, 0 and 380.

(1) $$325 - 0 = 325.$$

$$\frac{325}{5} = 65, \text{ and } 325 - 65 = 260.$$

(2) $$380 - 325 = 55.$$

$$\frac{55}{5} = 11, \text{ and } 325 + 11 = 336.$$

Position of Jack Shaft.

It is considered by some people that the arrangement of the differential motion shaft above the centre of the lift causes the rovings to be slackened in the winding more at one extremity of the lift than the other. Messrs. Howard & Bullough, with their new motion and rearrangement of various parts, manage to put their differential motion and pulley shaft more in the middle of the lift of the bobbin, thus tending to minimise the evil alluded to.

Q. Referring to the slubbing, intermediate and roving frames, say whether, when the bobbin leads the flyer, its speed is accelerated or reduced on the completion of the winding of each layer of slub or rove; also say what is the case when the flyer leads the bobbin, and state the practical disadvantages which have led to this arrangement being generally abandoned.

A. On these bobbin and fly frames in all cases the spindles and bobbins revolve the same way as each other, and in all cases winding-on is accomplished by having either the spindles revolving faster than the bobbins, or else the bobbins faster than the spindles.

The latter is now almost the universal practice, and is termed "bobbin leading".

In this case the speed of the bobbin is reduced on the completion of the winding of each layer, while it is increased in the case of flyer leading. In all cases, so long as the machines are working, the speeds of the flyer and bobbin are most nearly equal to each other just before doffing.

The discontinuance of flyer leading has been principally brought about by two disadvantages:—

(1) When a roving broke, the loose end often began to unrove from the bobbin and to fly about and make waste and break other ends, and this is not the case with bobbin leading.

(2) Every time the frame was started with flyer leading there was a tendency to stretch the rovings, due to the backlash in the nine wheels which drive the bobbin being more than that in the five wheels which drive the spindles, while with bobbin leading this only tends to slacken the roving slightly.

VARIOUS CALCULATIONS.

Q. How many hanks and pounds per spindle can be produced from the following: Revolutions of spindle, 650; turns of spindle for one of front roller, $5\frac{1}{2}$; diameter of front roller, $1\frac{1}{4}$; working hours of frame, 48; hank roving, $3\frac{1}{2}$?

A. (1) $\frac{650}{5\cdot5} = 11\cdot81$ revolutions of front roller.

(2) $\frac{11\cdot81 \times 5 \times 22 \times 60 \times 48}{4 \times 7 \times 12 \times 3 \times 840} = 44\cdot3$ hanks per spindle.

(3) $\frac{44\cdot3}{3\cdot5} = 12\cdot65$ lb. per spindle.

Q. What twist wheel would be required to give five turns of spindle to one of front roller from the following: Driving wheel, 54; outside spindle shaft wheel, 54; skew gear wheel, 50; wheel on spindle, 26 teeth; top cone drum inside wheel, 30 teeth; top cone drum outside wheel, 40 teeth; front roller wheel, 115 teeth?

A. (1) $\frac{1 \times 54 \times 50}{54 \times 26} = 1\cdot92$ revolutions of spindle to one of frame shaft.

(2) For five revolutions of spindle we get one revolution of front roller, what revolutions shall we get of front roller for 1·92 of spindle?

$$\frac{1\cdot92 \times 1}{5} = \cdot384 \text{ revolutions of front roller to one of frame shaft}$$

We have now the particulars for a final speed calculation.

(3) $$\frac{\cdot384 \times 115 \times 30}{40 \times 1} = 33\cdot12 \text{ twist wheel.}$$

Q. A mill working Egyptian cotton and spinning 60's twist contains 50 mules of 1,020 spindles each, and produces 19,125 lb. of yarn in a week of 56½ hours. The slubbing frame produces 19,800 lb., and each slubbing spindle produces 50 hanks of 1-hank roving. The intermediate frames produce 19,650 lb., each spindle producing 48 hanks of 3-hank roving. The roving frames produce 19,500 lb., each spindle producing 39 hanks of 11-hank roving. (1) How many frame spindles of each sort are there in the mill? (2) What is the draft in the frames? (3) How many hanks per spindle per week are these mules doing? *Note.* -The slubbers are supplied with a ·20 hank sliver from the drawframe.

A. (1) Spindles required:—

Slubbing = 19,800 ÷ 50 = 396 spindles.
Intermediate = 48 ÷ 3 = 16 lb. per spindle,
and 19,650 ÷ 16 = 1,228 spindles.
Roving frame = 39 ÷ 11 = 3·54 lb. per spindle
and 19,500 ÷ [illegible]·54 = 5,508 roving spindles.

(2) Drafts:—

Slubbing frame draft = 1 ÷ ·2 = 5 draft.

Intermediate frame draft $= \dfrac{3 \times 2}{1} = 6$ draft.

Roving frame draft $= \dfrac{11 \times 2}{3} = 7\cdot\dot{3}$ draft.

Mule draft $= \dfrac{60 \times 2}{11} = 10\cdot90$ draft.

(3) Mule hanks per spindle:—

$$\frac{19{,}125 \times 60}{50 \times 1{,}020} = 22\tfrac{1}{2} \text{ hanks.}$$

Q. 1896. What is meant by a "constant number" in making calculations? Give an example of its use.

A. A "constant number," as used in the cotton trade, is a "dividend" which may at any time be divided by some required quantity or condition, and the quotient thus obtained will be the wheel necessary to be put on to give the required condition; or the converse of this rule may be used. Thus, "a dividend for change pinion is a number which, divided by any required draft, will give the necessary change pinion, or divided by any change pinion will give the draft". "A dividend for twist is a constant number, which if divided by any desired turns per inch will give the requisite twist wheel. If divided by any particular twist wheel, it will give the turns per inch to be put in." Where a number of machines are working with certain wheels that are seldom changed, whilst at the same time the counts are often varied, there is no doubt that "constant numbers" are exceedingly useful. The use of the constants gives us a kind of shorthand arithmetic, and in this respect they fill a similar position to the slide rule. They are of little use in mills which do not often change counts. Our remarks may first be illustrated by the change pinion for draft. It is well known that the front roller wheel, crown wheel, back roller wheel and diameter of back and front rollers are seldom varied as compared with the change pinion. When we have a little leisure time therefore in the mill we can take the above five particulars and work out a draft calculation as far as it will go. For instance, we will assume the following particulars to be on a self-acting mule, bearing in mind that exactly the same kind of working will apply to the ring frame, bobbin and fly frames, some draw-frames, the carding engine, etc.:—

Wheel on front roller	18	teeth.
Wheel on back roller	54	,,
Crown wheel	90	,,
Diameter of front roller	1	inch.
Diameter of back roller	1	,,

$$\frac{90 \times 54 \times 1}{18 \times 1} = 270 \text{ constant.}$$

To show now the practical utility of this constant: The number 270 is kept conveniently recorded, and if at any time we desire to find the roller draft we simply divide by the change pinion which happens to be on. Thus, if there be a 35 change pinion on, the draft will be found as follows:—

$$\frac{270}{35} = 7{\cdot}71.$$

If, on the other hand, we desire to find what draft a certain change pinion will give, we simply divide the constant by the change pinion. Thus, if there be a draft of 8 required, the change pinion necessary will be:—

$$\frac{270}{8} = 33{\cdot}75, \text{ or, say, } 34.$$

For getting the twist constant we should adopt substantially the same method, but the calculation is a much more complicated one. An excellent general rule is laid down on page 18 of Thornley's *Spinning Calculations*, and the same rule applies to finding the twist constant, excepting that the twist wheel is left out of the calculation. The rule referred to is as follows: "Assume the speed of the central shaft of the machine to be one per minute, and by the rule for speeds find the revolutions of front roller per minute, and also of spindles per minute. From speed of front roller find inches delivered per minute. Divide the inches delivered into revolutions of spindle per minute." This rule is illustrated by several examples, of which the following is one: On the tin roller of a ring frame is a 40 wheel driving an 85 stud wheel; on the same stud is a 45 twist wheel driving, by means of carriers, a 100 on front roller; diameter of front roller 1 inch, diameter of tin roller 10 inches, diameter of spindle wharf $\frac{3}{4}$ inch. This calculation is worked in parts as per above rule, and then the parts are compounded into one operation as follows:—

$$\frac{1 \times 10 \times 4 \times 85 \times 100 \times 7}{3 \times 1 \times 40 \times 45 \times 22} = 20 \text{ turns per inch;}$$

and the twist constant is found by simply leaving out of the above calculation the 45 twist wheel, thus:—

$$\frac{1 \times 10 \times 4 \times 85 \times 100 \times 7}{3 \times 1 \times 40 \times 22} = 900 \text{ constant.}$$

If we desired to put in twenty-five turns per inch, we simply divide the 900 by 25, and we obtain the requisite twist wheel. Thus:—

$$\frac{900}{25} = 36 \text{ twist wheel.}$$

The foregoing answer deals with the subject to a much fuller degree than would be practicable at an examination,

Q. 1899. In the course of building a set of bobbins on a roving frame, it is noticed that instead of being properly wound the coils run over. To what causes would you attribute this; which parts of the machine would you examine, and in what order? Give fully the reasons that would influence you.

A. In 1898 the equivalent question on the roving frame asked for the remedy when the coils were too close or open, the answer required being that a proper size of lifter driving wheel should be put on. Running off at the ends, which is the subject of this present question, is a very serious evil when present to any extent. Remedies adopted at one time or another are as follows: See that the lifter works with all the freedom possible, and does not bind in the collars or racks; see that sufficient cone is put into the bobbins; see that none of the wheels concerned in driving the lifter from the cone drums to the rail itself are badly worn in the teeth or slack in the studs. Also see that these wheels are geared sufficiently deep. See that the catches and cradles and hanger bar of the change motion work freely enough, and have all parts of the change motion in good condition. Sometimes bobbins run off owing to the frame being stopped just at the change, or possibly owing to the winding being very slack. Odd bobbins are spoiled at the ends in various other ways. As to order of looking for the cause of the evil, this would depend on a number of circumstances, such as certain frames being given to going wrong in special places more than others. The character of the running off would help an overlooker, or he might have been previously doing some alterations or repairs that had led to the evil.

Q. 1899. Suppose you were making a six-hank roving, and you had to change to a four-hank, in each case retaining the same lift, what changes would you make, and in what order? Give fully the reasons that would influence you.

A. Such an alteration as this is often made in one mill or another, and it is seldom indeed that in such a case the length of lift is varied. As a rule, the changes made would be practically confined to the following four wheels, and it would be of little or no importance in what order the changes were made:—

(1) Change pinion for draft. (2) Twist wheel. (3) Ratchet or rack wheel. (4) Small strike wheel or lifter wheel.

(1) To find the change pinion for draft the following rule would be correct:—

$$\frac{6 \times \text{Present change wheel}}{4} = \text{C.P.}$$

(2) Star or ratchet wheel—

$$\frac{\sqrt{\text{Present rack wheel squared} \times 4}}{6} = \text{R.W.}$$

(3) Twist wheel—

$$\frac{\sqrt{\text{Present twist wheel squared} \times 6}}{4} = \text{T.W.}$$

(4) Lifter wheel—

$$\frac{\sqrt{\text{Present lifter wheel squared} \times 6}}{4} = \text{L.W.}$$

As regards reasons, a larger C.P. must be put on in order to increase the speed of back roller sufficiently to reduce the counts, while the front roller speed is not affected by this wheel. A larger twist wheel must be put on in order to speed all the rollers sufficiently to reduce the twist per inch, as the spindle speed remains unaltered. Square root is used because twist per inch varies directly as the square root of the counts. The rack wheel is made less in order to quicken the travel of the cone drum belt, while the lifter wheel is made larger in order to get the speed of first lift of the bobbins right. Square root is used in the two last named cases because the diameters of rovings vary inversely as the square roots of the counts.

Q. 1900. Say fully what differences there should be in constructive details of drawing and roving frames used respectively for the preparation of 28's from good Broach cotton, and 150's combed yarn from Egyptian cotton.

A. An important difference is found in the diameters of the drawing rollers in each case. On a drawing frame for the Broach cotton suitable diameters of the bottom iron rollers would be $1\frac{1}{8}$ inch for the first, third and fourth rollers, and 1 inch for the second roller from front. For the Egyptian cotton suitable diameters would be $1\frac{1}{2}$ inch for the first, third or fourth rollers from front, and $1\frac{1}{4}$ or $1\frac{3}{8}$ inch for the second roller from front. For the Egyptian cotton we might have about 17 lb. weight on either end of the top leather rollers, and, say, about 20 lb. for the Indian cotton.

On a roving frame the diameters of rollers for the Broach might be 1 inch, $\frac{7}{8}$ inch and 1 inch for the bottom rollers and $\frac{13}{16}$ inch or $\frac{15}{16}$ inch for all the top rollers, and those for the Egyptian $1\frac{1}{4}$ inch, $1\frac{1}{8}$ inch and $1\frac{1}{4}$ inch bottom, and $1\frac{1}{8}$ inch top if dead weighted. On the drawing frame it is probable there would be six ends doubled together for the Broach and eight ends for the Egyptian, although there is no hard and fast rule in this matter. Any difference in the number of doublings would probably be accompanied by a corresponding difference in the amount of draft.

On the roving frame it is probable there would be less sizes of spindles and bobbins used for the fine counts than for the coarse, but there would be more roller draft and larger diameters of rollers for the finer counts. On both machines the measuring motions would be set to knock off at longer intervals for the finer counts, and also for the latter the spoons would require finer balancing. Some spinners would have no pressers for the fine roving.

CHANGE MOTION.

Fig. 13 shows an ordinary building motion, to which is applied a weight-relieving device, which is the invention of Mr James Lucas, one of Messrs Howard & Bullough's employees, who have adopted it in their slubbing, intermediate and roving frames. The invention consists in the application of an auxiliary arrangement which raises the tumbler weights alternately, and at the proper time, in order to relieve the hanger bar already referred to of any strain whatever. By referring to the illustration it will be observed that a pendant, A, is attached to the under side of the two-bar slide, B, which in turn is secured to the top rail in the usual manner. Upon this pendant are two adjustable stop pieces, A^1 and A^2, between each of which an arm, C, passes. This arm swivels upon an independent centre stud, and forms a sort of cradle at D, the two extremities of which are notched to take in the two weight hooks, E and E^1. Each weight hook is extended through eyes in the holding catches, F and F^1, and are both formed with stop pieces, so that when descending they bring with them the catches named, their lower extremities being connected with the weights in the usual manner. A brief glance at the illustration will show that the upright rods suspending the tumbler weights are no longer connected with the upper cradle, but are worked independently by the rocking lever or arm, C. In whichever direction the bobbin rail moves, the rocking lever is caused by the stops, A¹ and A², to move with it, and thus raise one

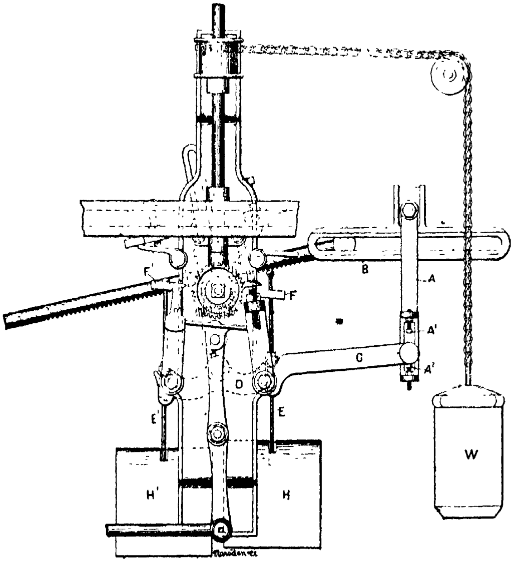

FIG. 13.

of the weights, while the opposite one will come into action just at the time the necessary changes in the position of the cone strap are taking place. The author is quite of opinion that this is a step in the right direction.

Briefly, the action of this motion as hitherto applied is as follows: When the bobbin rail ascends it carries with it the two-bar slide and the hanger or radial bar. This latter turns the tumbler bracket partly round its centre until the adjusting screw relieves the catch bracket, to which is connected the strike shaft and wheels employed to give the reverse motion to the bobbin rail. In order to give a quick motion to these wheels, strong springs or heavy weights are used. These springs or weights also relieve the catches from the ratchet wheel so as to allow the drag weight to move the hanger bar and the cone strap to their necessary positions. In order to facilitate the lateral movement of the cone strap, especially in long frames, a heavy drag weight is used, and to enable the catch bracket to revolve freely round its axis at the time the change is being made the strain of one of the tumbler springs or weights has been taken up by the hanger bar. It will be observed that this strain is increased when the hanger bar has reached the angular position shown in sketch, which counteracts the action of the drag weight. That is, the tumbler weights or springs, to give the lateral motion to the strike shaft, retard the action of the drag weight and prevent the movement of the cone strap. Hence some time is lost before the bobbins are driven at their lower speed. Although this dwell of the bobbins may not be of long duration, the period may be sufficient to result in permanent injury to the finished sliver, especially in frames where there is a tendency to tight winding. It may be added that certain other makers are now applying much similar motions.

Cap Bars.

In previous years the cap bars which sustain the leather-covered rollers have not been in all cases constructed with sufficient accuracy, making it difficult to maintain the rollers properly in position. During recent years various improvements have been effected in this respect, and Fig. 14 shows the cap bars as made for fly frames by Messrs. Howard & Bullough. The various parts of Fig. 14 are also numbered separately. These improved bars have now been working for some years.

The principal improvement relates to the form of the fingers which carry the "nebs" or bearing blocks for the top rollers and the manner of securing the brackets, to which the fingers are attached to the bracket shaft.

The illustrations show in Figs. 1 and 2 a back and side view of the parts which form the cap bar respectively as applied to a frame with four spindles in a box, and Figs. 3, 4 and 5 enlarged views of the details. The finger *a*, instead of being square as hitherto, is formed pentagonal or five-sided in section, all the sides being equal. The lower portion of the hole in *b* is also specially formed, being cut out V-shape, so that when the finger is placed therein one of the flat sides must be uppermost, and thus present a level surface for the set screw, *c*. Precisely the same principle is carried out with regard to the mounting of the nebs, Fig. 5 showing the shape of the hole.

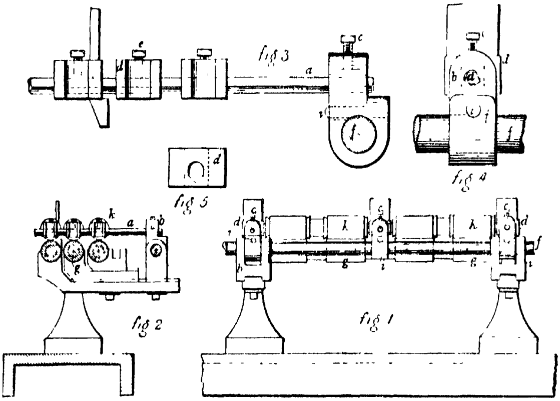

FIG. 11.

It will be clear to the reader that by providing two angular bearing surfaces, with a flat one for the screws, the latter may be tightened without fear of twisting or forcing the nebs out of line with the opposite ones, thus securing correct alignment of the top rollers. To prevent the brackets, *b*, from twisting on the shaft, *f*, and allowing the "nebs" to fall into contact with the fluted bottom rollers, a groove, *h*, is cut transversely across the upper part of the shaft, as shown in Fig. 4. This groove admits of the insertion of a taper key, *i*, which holds the bracket securely in its place.

It will thus be seen that whereas the old bar had no facility for adjustment, the new one provides for accurate adjustment in all directions. It will be noticed also that the cap bar is fixed on the stand by an independent bracket, and the roller slides are free to move and allow of the rollers being altered without moving the cap bar, nor does the neb for the front top roller require to be disturbed, only the nebs for the other rollers having to be re-set after moving the bottom roller. The iron top clearer is hinged on the cap bar shaft, which is not disturbed by the moving or cleaning of the bottom roller. From what has been said it will be apparent to practical spinners that a very considerable improvement has been effected in an important part of these frames.

MULES.

Q. When mules are fitted with the ordinary long copping rails, and copping perfectly, what would be the effect (1) if the back plate were brought inwards half an inch; (2) the vertical screw, which carries the front end of the rail, moved downwards four complete turns?

A. (1) If the back plate were brought in it reduces the inclination in the copping rail, leading to—

(*a*) Shortening of the chase of the cop rather substantially all through the set of cops, but the shortening effect would be far the greatest for the first few minutes after doffing.

(*b*) It would make the bottom cone of the cop longer and thinner, owing to the total fall of the rail being made greater during the time that the copping rail is resting on the coning incline of the front plate.

(*c*) Except in the case of the bottom cone, the cop would be made very slightly thicker, as this is an effect which follows shortening of the chase.

(2) (*a*) By screwing down at the vertical copping rail screw, broadly speaking the opposite effect is produced to that by pulling in the back plate, *i.e.*, the inclination of the copping rail is increased.

(*b*) This would lengthen the chase in an equal proportion all through the set.

(*c*) It would make the cops somewhat thinner. It must be noted that altering the position of the back plate may affect the length of the bottom cone of cop, which is not the case with altering the vertical screw; also that variations in the length of chase may affect the depth of faller locking.

Again, while alterations in the back plate affect the length of chase far more for the first few minutes after doffing than when the cops get larger, alterations by the screw give equal proportions through the set.

Fig. 15 may be used to illustrate the answers on copping. A is the front plate; B is the middle plate or loose incline plate; C is the back plate; D is the loose front incline of copping rail used to regulate the depth of lock and the amount of crossing thread; E is the long and principal incline of the copping rail; F is the vertical screw by which the length of cop chase is regulated; G is the vertical screw by which the relative inclination of the loose incline, D, is regulated, and consequently by which the depth of faller lock is determined; H is the steady or stay bracket, by which the copping rail is kept firmly in position, although quite free to move upwards and downwards. J is the front extremity of the builder motion worm with the builder wheel, K, at its inside extremity; M is the stud by which the rear end of the copping rail is sustained on the back copping plate.

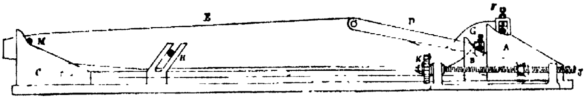

FIG. 15.

Q. When mules are fitted with the ordinary long copping rail and movable incline, if the cops made are faulty, as in the three cases named, describe the alterations required in the apparatus without filing. (1) Thinner at the top of the cop than the bottom, and long cop nose. (2) Long chase during early draws. (3) Short stuff bottoms causing running under and short chase.

A. (1) In many cases when cops are thinner at the top than at the bottom, and there is a longer cop chase at the top than the bottom than there ought to be in proportion, a remedy may be effected by alterations in the sector. It may be stated that when the centre of the sector stud is in the same horizontal plane as the centre of the winding faller shaft, the winding faller wire should be in the centre of the working length of the spindle blade in order to give a parallel cop. By placing the sector stud in position indicated and then lifting the winding faller wire an inch or more up the spindles we should expect an improvement to result in the cops under discussion. Another remedy might be to have less of the front copping plate in action so as to thin the lower portion of the cop, while the chase could be shortened by the vertical screw of the copping rail.

(2) Long chase during early draws is usually caused by having an insufficient amount of the back plate working. Owing to the shape of this plate if we drew it in to have the rail resting on a higher portion of the plate the chase will be shortened all through the building of the cops, but far more during the early draws than at a later stage.

(3) The question may be taken as referring to either the portion of cop made during the early draws or to the bottom cone of the cop.

Suppose the cop bottoms as made during the early draws were short and stiff, then running under might occur during the first few minutes. A remedy might be found by pushing the back plate a little bit out of action so as to lengthen the bottom. If the chase is short all through the set, then it might be lengthened by raising the front end of the copping rail by means of the front vertical screw of the rail. Taking the question as in coning that the bottom cone of the cop is too short and stiff, then the remedy might be found in putting more of the back plate at work and keeping the front plate as before, as this would lengthen out the bottom cone and make it proportionately thinner owing to the fall of the copping rail being increased while only the same amount of yarn is put on the bottom cone as before. The chase could be altered by the front vertical screw of the rail as before.

Q. 1898. What are the principal changes necessary in a mule if it be desired to build a shorter and thicker cop than the one being made? Give brief reasons for each step.

A. This alteration is a peculiar one, and by no means typical of what takes place in actual practice. If the examiner had asked for the alterations necessary in changing to a shorter and thinner cop instead of shorter and thicker cop, then it would have been one of the best practical questions ever set, as it would have been equal to asking for the changes necessary in changing from twist cops to pin cop weft.

Taking the question literally as given, in building a shorter cop there will be no steps necessary unless— as in the case of thinner cops—we desired to start building the cops further up the spindles. Simply to build shorter cops we should stop the mule and doff it so much sooner. To make thicker cops we should, of course, put on a larger builder wheel in proportion to the amount of increased diameter of cop required. The thicker the cops the larger should be the chase and the bottom cone of the cops as a matter of principle. The vertical screw at the front end of the copping rail might be screwed down somewhat in order to give the requisite degree of inclination to the copping rail to produce the length of chase required.

To give the requisite length and diameter of bottom cone of cop required for the thicker cops, a little more of both back and front copping plates might be put into action.

If it were desired to start building the cops higher up or lower down the spindles, as the case might be, then it would be necessary to alter the locking lever so as to start the winding at the position required.

If the cops were made very much thicker it would be probably necessary to spin only on every alternate spindle, and in such an extreme case it would also be probably the best practice to put on a larger winding drum, so as to give a slower speed of spindles during winding-on.

Granting also that the counts of yarn were to be changed at the same time, then all the change wheels would have to be altered in the proportion required. For a large change alterations in the bevels of spindles and setting of fallers might be necessary to give the best results.

Q. 1898. A mule is found to be making a cop with a concave body. What is the cause of this defect? How would you remedy it?

A. When cops vary in diameter it is much more frequently the case that they gradually taper thinner or thicker upwards, as the case may be, without again recovering their original diameter, and making a hollow-shaped or concave body, as suggested in the question. Such a defect, however, we have frequently witnessed, as also its exact opposite, or a convex bodied cop. As we have frequently demonstrated at one time or another, when cops vary in diameter or "squareness" of body it will be usually found that the defect originates from the plates. In the case under discussion, having first ascertained that there was nothing loose or badly worn about the copping parts, and granting that the defect exists in every set of cops being spun, it would probably be the best plan to at once make an examination of the plates. A sufficient knowledge of their correct configuration would enable us at once to tell whether they were correct in this respect or not, our examination extending, of course, both to the back and the front plates. We strongly recommend the possession of templets by overlookers, managers, fitters, etc., who may have to do with copping. These can be at once applied to the working surfaces of the plates, and any defects thereby shown up in an instant. A defect like the one mentioned in the question would probably emanate from the plates—either one or both of them—having too rapid a fall or incline at the point whereon the copping rail would be resting when the concavity in the cops was caused. It could be caused by a concavity or extra steep place in the back plate alone, which would cause the chase of the cop to lengthen at that portion and afterwards to shorten again, this being certain to result in the defect under discussion. To remedy it we could file the plates backwards and forwards towards the initial and terminal points from the concave portion in order to reduce the surfaces approximately to the same inclination, having regard to the fact that it is good practice to have the back plate rather less steep than the front plate in order to gradually shorten the chase and get more weight on the cops. In this filing, as we have said, anyone who was not pretty sure of the effect of his filing would do well to work to templet, and even an expert would be assisted in his work in most such cases. Another way in which such a defect might possibly be remedied would be to put less coning incline of front plate at work, so as to thin down the base of the cop to the same diameter as the concave portion, after which the upper portion of the cops might be thinned down by filing the back plate alone, or both plates, as the case might be, from the concave portion down to the terminal point. After the cops had been got right by filing plates, it is very probable that the shaper would require altering in size to maintain a correct diameter of full cop. In all such cases of copping the exact procedure which is best suited to any one case can only be determined by an examination of local conditions. In other cases, after putting a less amount of coning incline to work, we might drop the faller wire in relation to the sector, so as to thin the upper portion of cop. It may be noted that with short copping rails it has long been quite common to make the coning incline of the front plate straight, or even convex, and there is a tendency with some people to adopt the same practice with the front plate for the long rail.

THE MOORHOUSE DRIVING FOR MULES AND TWINERS.

Recently it came to the knowledge of the author that Mr. Moorhouse—one of the inventors of the well-know duplex driving—had made other and still more radical alterations in the mechanism of mules and twiners, and had a mule working at the fine mill of the Park Road Spinning Company, Dukinfield.

As the author is anxious to present his readers with interesting and profitable information with regard to such matters, he proceeded to personally view and study the apparatus.

It may be stated that the author was favourably impressed with Mr. Moorhouse's new invention, and is of opinion that it will receive some application in the future, at any rate for mules of moderate spindle speed. Although it effects very great changes in the construction of the headstock, yet it is capable of application to existing mules of almost any make.

It may be stated that in this new arrangement the parts relating to the changes and winding-on remain substantially untouched. While a different method of driving the rim shaft is adopted, the rollers and carriages are driven from the rim shaft by exactly the same mechanism as before. The spindles, however, are driven directly from the counter shaft during the actual operation of spinning and indirectly from the backing-off friction, and the usual down band during backing-off. Perhaps the greatest objection to it is the

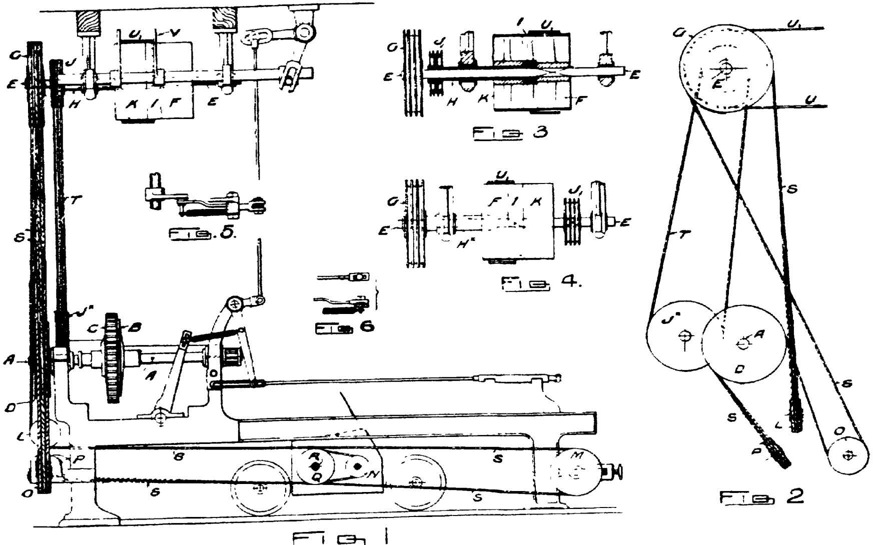
Fig. 1
Fig. 2
Fig. 3
Fig. 4.
Fig. 5.
Fig. 6
G
E
H
J
J'
J''
U
U'
V
K
I
F
T
S
A
B
C
D
L
O
P
M
N
Q
R
H''

FIG. 15 (a).

On the accompanying drawing Fig. 1 illustrates a side elevation of the headstock of a mule and overhead counter shaft with this invention applied thereto.

Fig. 2 illustrates a back view of the pulleys and bands.

Fig. 3 illustrates the belt pulleys, belt, taking-in pulley and sleeve on the counter shaft and the bearings of such shaft in section.

Fig. 4 illustrates a modification.

Figs. 5 and 6 illustrate certain details in plan and elevation.

To the rim shaft, *A*, are applied the usual backing-off friction cones, *B* and *C*. To the said shaft and outside the headstock is also applied, by preference, a three-grooved pulley, *D*. To the counter shaft, *E*, is applied a fast belt pulley, *F*, a fast band pulley, *G*, and a loose sleeve, *H*. Upon this sleeve is keyed or fixed a narrow belt pulley, *I*, and band or taking-in pulley, *J*. Also upon such sleeve is mounted a loose pulley, *K*, and the three pulleys *F*, *I* and *K*, lie side by side as illustrated.

Around the pulleys, *D* and *E*, and carrier pulleys, *L*, *M*, *N*, *O* and *P*, also the pulley, *Q*, on the tin roller shaft, *R*, is passed an endless rope band, *S*, the tension of which is regulated by the adjustment of pulley, *M*. Around the pulley, *J*, and pulley, *J'*, on the mule headstock connected with the taking-in mechanism is passed a band, *T*.

Around the pulley, *F*, *I* or *K*, is passed the driving strap, *U*, which under the traverse of a strap guider, *V*, is designed to traverse on and off the pulleys, *F*, *I* and *K*, as hereinafter described.

During the outward run of the mule carriage, and whilst spinning is designed to take place, the said strap lies partly on pulley, *F*, and partly on pulley, *I*, and the motion thereby imparted is then transmitted to the spindles, *via* shaft, *E*, pulley, *G*, band, *S*, and pulley, *D*. Such motion is, by preference, also transmitted, *via* pulley, *I*, sleeve, *H*, pulley, *J*, and band, *T*, to the "taking in" mechanism, to keep such mechanism in motion ready for the time when the changes require to take place.

When the mule carriage reaches the end of its outward run and "backing-off" is designed to take place, the strap, *U*, is moved off the pulley, *F*, until it is on the pulley, *I*, and partly on to the loose pulley, *K*, as partly shown in Fig. 1, thereby ceasing to drive the pulley, *F*, and band, *S*, and driving only the pulley, *I*, sleeve, *H*, pulley, *J*, band, *T*, and, with the backing-off frictions engaging simultaneously with such change and reversing the rotation of the rim shaft and the band, *S*, effecting the reversal of the spindles for backing-off.

When "backing-off" is completed, and the carriage has made its inward run, the strap, *U*, is moved back again on to the pulley, *F*, and again drives the spindles, *via* pulleys, *G* and *D*, and band, *S*.

By the substitution of a pulley of larger or smaller diameter for the pulley, D, it will be seen that the speed of the spindles in backing-off may be varied without varying the speed of the spindles in spinning, and that by the substitution of a pulley of larger or smaller diameter for the pulley, *E*, the speed of the spindles in spinning may be varied without varying the speed of the spindles in backing-off. In such way is allowed for the humouring of the speeds in a simple manner to suit requirements.

The means employed for operating the strap guider, *W*, are, by preference, shown in Figs. 1, 5 and 6 of the accompanying drawings.

In lieu of the arrangement of pulleys shown in Figs. 1 and 3 may be employed the arrangement shown in Fig. 4, in which pulleys, *F* and *G*, are loose upon the counter shaft, but are connected together by the sleeve, *H'*, and the pulleys, *I* and *J*, are keyed direct to the counter shaft. The lateral movements of the strap, *U*, in this arrangement are the same as in the arrangement shown in Fig. 3 but in an opposite direction.

In a more recent arrangement the inventor employs four grooved pulleys on the counter shaft and the rim shaft, but only two grooves in the tin roller pulley.

difficulty of getting a high spindle speed. Also it is possible the rim-band may rove too much and be difficult to put on again.

OBJECTS OF INVENTION.

The patentee puts the case well when he says that "this invention has for its object to improve the driving of self-acting mules and twiners, and has special reference to the regulation of speeds requisite for spinning and backing-off, and to the economical use of bands, pulleys and space in and about the headstock.

Every practical man can understand something of what is meant when it is stated that the fast and loose pulleys on the rim shaft, in the middle of the headstock, are taken completely away, and in that position, at any rate, practically no other mechanism is substituted. There is, however, a somewhat radical rearrangement of the position and parts of the top counter shaft. While a grooved pulley is maintained at the rear extremity of the rim shaft, similar to all intents and purposes to the usual rim pulley, this pulley in the Moorhouse mule does not drive the spindles during spinning, but really takes the place of the usual fast belt pulley of the headstock. On the rear extremity of the counter shaft is fixed a grooved rope pulley similar to the rim pulley on the rim shaft, and this pulley takes the place of the usual driving drum on the counter shaft. Around this pulley on the counter shaft and the rim pulley on the rim shaft, also around the tin roller pulley and carrier pulleys for the rim band, is passed the endless rim band.

As stated, in this invention the usual fast and loose pulleys in the headstock are entirely dispensed with, along with the large driving drum on the counter shaft. In place of this driving drum, but on the rear extremity of the counter shaft, is fixed a grooved pulley similar to the rim pulley. The rim band, in addition to passing round the tin roller pulley and carrier pulleys, is made to extend up to this grooved pulley on the counter shaft, so that during spinning the usual rim pulley is simply a carrier so far as the driving of the spindles is concerned.

As regards the driving of the rollers and carriage the usual rim pulley becomes the driven fast pulley of the rim shaft, the latter shaft thus receiving motion from the counter shaft by means of a double or treble rim band, instead of the usual down belt. The driving of the rollers and the carriage from the rim shaft remain untouched. This manner of driving spindles, rollers and carriage by the same band tends to give uniformity of twist.

The Counter Shaft and Direct Driving.

Although the counter shaft is simplified by the usual driving drum being dispensed with, on the whole it contains rather more mechanism than usual. It will be remembered by some of the older practical men that formerly what is termed "direct driving" was very largely employed for mules on all counts, and it has come under the author's observation that this method is still retained in many mills spinning the finer counts. With direct driving the counter shaft and the usual down belt are not used, and the top belt is connected direct to the rim shaft.

The new arrangement of driving during actual spinning operations might be described as a compromise between the direct and indirect methods. The counter shaft is used, but half the usual number of belts and belt drums are dispensed with.

The counter shaft may be allowed to remain in the usual position close to the ceiling—especially in the case of existing mules adapted to the new driving—but the inventor prefers to have substantial pedestals mounted on the headstock, so as to sustain the counter shaft and its various parts about three feet above the usual rim shaft. Upon the counter shaft are arranged fast and loose pulleys, and between these pulleys is placed an intermediate pulley, carried by a sleeve, which loosely fits the counter shaft. Upon this sleeve the loose pulley is mounted, and to it is connected the usual taking-in or friction band pulley. Also, as before stated, there is fixed on the counter shaft a grooved pulley similar to the rim pulley. The effect of this combination is that as soon as the driving strap is applied to the fast pulleys on the counter shafts, and spinning is required, the driving is direct from the counter shaft. It must be clearly understood that the top driving belt is moved backwards and forwards on the fast and loose pulleys of the counter shaft at every stretch in the same manner as the down belt is moved on most mules with the usual existing arrangements. In this respect the movement of the top belt much resembles that of the top belts in Messrs. Dobson's double speed arrangements for fine mules.

BACKING-OFF AND TAKING-IN.[1]

During actual spinning the taking-in band or friction band may be kept running as usual, thus rotating the loose halves of the friction couplings of the cam shaft, taking-in and backing-off mechanisms, ready for action at the proper time for engagement of these frictions.

Immediately the operations of backing-off are designed to take place, the driving belt is moved off the fast pulley of the counter shaft, so as to be on the narrow intermediate pulley and partially on to the loose puliey, and therefore the counter shaft practically stops and the rim shaft ceases to be driven by the counter shaft pulley, just as in ordinary mules it ceases to be driven by the down belt. As per usual, the backing-off friction engages and takes command of the rim shaft and spindles during backing-off, and the diameter of the ordinary rim pulley affects the speed of the spindles during this period as on ordinary mules.

It is in the fact that the rim pulley performs dual functions that one of the principal features of this invention consists. During actual spinning the rim pulley is only a carrier pulley so far as the speed of spindles is concerned, and a variation in its diameter would have little or no direct effect on the spindle speed during spinning.

On the other hand, the rim pulley is the driving pulley for the spindles during backing-off, as on ordinary mules, and an increase in its diameter would result in quicker backing-off.

The author himself has for some time been working at improvements in regard to the driving of mules, and gives it here as his opinion that whatever may be the success of Mr. Moorhouse's new driving, it is highly probable that before long one or other new method will come into extensive operation.

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[1] A novel and promising method of independent backing-off has just been invented and put to successful working by Mr. Sampson of Oldham.

Q. 1899. What happens in a mule if the backing-off friction fails to gear properly? What are the chief causes of its slipping? What precaution would you take to ensure its working properly?

A. If the backing-off friction of a mule fails to gear properly the mule simply stops at the head until the requisite steps are taken to start it off again. The friction keeps on rotating, but cannot take the rim shaft round because of imperfect engagement. (Care should be taken to distinguish between this action and the mule stopping by the winding click prematurely dropping into gear.) The taking-in rope would rotate the loose halves of the cam and drawing-up clutches also. There are many causes of imperfect engagement of the backing-off friction, such as not being set sufficiently deep, the stop on the strap fork not moving far enough out of the way, the backing-off spring being too weak or too slack, the various levers not being centred correctly, the carriage not getting far enough out. Providing slipping were not due to any of these causes, it might be due to the friction being badly covered, or greasy or poor leather, etc. The precautions necessary to ensure proper working are to guard against such evils as above specified.

Q. 1899. You are supposed to be ordering mules to spin 120's from Egyptian cotton. Give the following particulars: (*a*) Speed of spindles, (*b*) gauge of spindles, (*c*) diameter of all bottom and top rollers, (*d*) whether solid or loose boss top rollers front line, (*e*) how many ends to boss, (*f*) draft of rollers between front and middle and between middle and back, (*g*) distance centre to centre of different lines of rollers, (*h*) lever or dead weighting, stating weight in either case, (*i*) length of stretch, (*k*) gain of carriage, (*l*) any other particulars which, in your opinion, are essential to the mule. Having given the draft you propose, state what hank roving you would use.

A. Different firms would give different answers to many of the above questions, so that the answers given below must only be taken as approximating to general practice. Single speed of spindles, 6,000 revolutions per minute, and double speed, 9,500. Gauge of twist spindles, $1\frac{5}{16}$ inch. Diameters of bottom rollers: Front and back, $1\frac{1}{16}$ inch, or

1⅛ inch, and diameter, middle roller, ⅞ inch. Diameter of top rollers: Front overall, 1¼ inch; middle, ¾ inch; back, 2 inches. Solid roller front top line. One end or thread to each boss. Draft of rollers between front and middle, say, 12, and between middle and back, say, 1·08, giving a total of 12·96. Distance centre to centre of back and middle rollers, say, 1⅝ inch or 1¾ inch. Distance centre to centre of front and middle, say, $1\frac{3}{16}$ inch. Dead weighting, giving about 2½ lb. on front line per individual thread, 2 ounces on the middle, and, say, 6 ounces on the back roller per thread. Length of stretch, say, 58 or 60 inches. Gain of carriage, say, 5½ inches. The mule should have on the motions special to fine spinning, such as ratching motion, winding and jacking roller delivery motions. Double speed belt, taking-in and rim motions might be left to the special opinions of the buyer. The hank roving would be found by a calculation taking into consideration the amount of ratch and gain, twist per inch, double roving, counts spinning and roller draft.

Q. 1900. You are watching the working of a mule, and notice that when the carriage is (*a*) running out or (*b*) running in, the spinning or winding is bad. Detail the faults that most frequently occur at either stage, and their causes. A short, but complete answer, is required.

A. During the outgoing of the carriage bad spinning may be caused by poor cotton, badly made bobbins, dirty or irregular rovings, defective condition of rollers, as regards setting, weighting, leather covering, over-drafting, etc. There may be too much or too little twist, too much "gain" or "ratch," or too high a speed of the carriage spindles and rollers. The traverse motion may be wrong. In very frosty, or in dry, hot weather, we may expect the threads to break very readily, and this evil is accentuated by the facility with which the cotton licks on the leather rollers.

Defective winding and thread breakage during winding may be caused by the following circumstances: Over-weighting of fallers, slippage of taking-in friction, slippage of winding-on click, too much nosing motion, not enough governing motion, defective copping or wrong setting of quadrant, weak carriages, diagonal rods and back shafts, and faulty adjustment of the various cords or bands. Some of the faults enumerated for carriage coming out also act detrimentally on the threads during winding-on. The foregoing are all more or less common faults, but do not exhaust the subject.

Q. 1901. How would you proceed to generally overhaul a mule? What parts require the greatest attention or the most frequent adjustment?

A. In a general overhauling of the mule it would be necessary to renovate various parts of the headstock, and attention might be devoted to this at the outset. Advantage should be taken of the opportunity to replace all badly worn wheels, or broken studs, brackets and other parts. The various frictions should be recovered, or at least skimmed up, and the various parts and framework of the headstock levelled up.

At an early stage we should turn our attention to the roller beams and roller stands and rollers. The roller beam should be thoroughly levelled up, and any worn brasses in the stands of the iron rollers should be replaced.

Roughly speaking, for repairing and resetting purposes, a mule may be divided into three portions: (1) The headstock; (2) the roller beam and all connected parts; (3) the carriage and all connected parts.

Referring now to the carriage and its parts, we have to deal with the slips, the lining up of the carriage, the height of the carriage, or what is the same thing, the height of the spindle points, the bevel of the spindles, the faller shafts, the faller sickles and wires and the tin rollers, which could be probably taken in the order stated. The parts which require most attention are such as above given.

In some cases after new mules have been working only a few months some people like to overhaul them slightly, the operation then consisting mainly in re-screwing and re-lining some of the parts.

Q. 1897. Assuming that you were examining twist cops spun on the mule, and that in the course of wrapping you found small snarls hidden in the cop nose, to what cause would you assign them, and how would you proceed to remedy them?

A. It is well known that one of the modern developments in the copping rail of a mule is to make the front incline much longer with the definite object of burying in the "chase" any snarls which may happen to be on the spindle points just prior to backing-off. A less important object of the long incline is to get a steady downward movement of the winding faller, in order not to break the threads.

The causes of snarls are exceedingly numerous, and the author has dealt with the subject elsewhere at great length. In an answer of this kind it is quite evident that only the leading causes of snarls can be mentioned. These may be briefly enumerated as follows: (*a*) Fallers unlocking too soon; (*b*) an insufficient amount of "gain" in the carriage; (*c*) the nosing motion, anti-snarling motion or hastening motion not being sufficiently at work; (*d*) the quadrant nut too high; (*e*) the faller wires being badly set, or the carriage not "lighting-in" squarely, etc. It may be here noted that a good deal of information respecting yarn is given farther on in this book.

Q. 1896 What is the "bevel" of the spindles of a mule? How is it measured and how altered if necessary? If there is too much bevel, what fault in the yarn is produced? Is it greater in twist or in weft mules?

A. By bevel of mule spindles is meant their inclination from the vertical. This is rendered necessary in order to allow the yarn to twist off the spindle points without breaking. Its amount may be determined or measured by dropping a plim line from the apex of the spindle and measuring the distance from the foot of the spindle to the line. There are specially constructed gauges for fixing the amount of bevel very readily. If it is required to be altered the following method might be adopted: Set a few spindles at the headstock to the bevel required by measuring the difference between foot and apex of spindle as indicated above. Then set the spindle bevel gauge to these spindles. Adjust a few spindles at the other side of the headstock and at each mule end by the gauge. Extend a string the full length of the mule a little above the correct spindles. Then proceed to set the bevel of the spindles from one end of the carriage to the other by means of the string and the gauge combined. The gauge shows whether we have the correct amount of bevel on the spindles, and the line of string shows whether we have the spindles all one distance from the rollers, or in other words, in a horizontally straight line. The bevel, of course, is adjusted by means of the carriage stays or rods, which are connected to the carriage at the back, and either to the top or bottom spindle rails at the front More bevel may be put in either by the top rail being pulled in or the bottom rail pushed out by the screwed rods. The string along the tops of the spindles will assist in determining which of the two must be adopted. There is generally more bevel in weft mules than in twist of the same counts, particularly when the lengths of the spindles are compared. This is because of the softer nature of the weft yarn, as taking bevel out or strengthening the spindles somewhat always puts more strain on the yarn. The finer the counts the greater the amount of bevel necessary. A good rule for medium yarns is to put in a quarter inch of bevel for every inch of spindle, and, according to this, a 17-inch spindle would have $4\frac{1}{4}$ inches of bevel. If there is too much bevel in the spindles snarls will result, and because of this in many firms the amount of bevel in their spindles has been reduced during recent years. If this procedure is carried too far of course it results in an excessive breakage of the ends. Bevel is most necessary when the carriage is nearly at the limit of its stretch, and least necessary when it is near the back stops, and if very easy and simple apparatus could be effectively applied for varying the amount of bevel as the carriage made its outward journey, it would doubtless receive wide adoption. The inclined slips brought out a few years ago

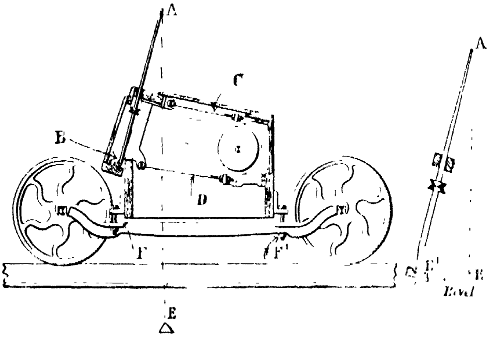

FIG. 16.

were intended to do this, but these "switchback" mules were accompanied by corresponding disadvantages to such an extent that they have met with little favour. Fig. 16 illustrates the parts requisite for an understanding of spindle bevel and its alteration. A, is the spindle point; B, the spindle footstep; C, the top stay rod used for alterations in bevel; D, is the bottom stay rod, used also for alteration of bevel; A, E is a vertical line used to show that by spindle bevel is meant the horizontal distance, E, E′, from spindle footstep to the line. The wood bolster and footstep rails are capable of moving about as required by the rods, C, D. By having two rods, C, D, we can more readily keep all the spindles in a straight line, as well as have the right bevel. F, F′ are the vertical rising screws, by which the "topping" or distance of spindle points from roller nip is regulated, and used sometimes to alter the bevel. On rare occasions spindle bevel is altered by putting in a different size of carriage wheels.

RING FRAMES.

Q. 1899. Give particulars of the supervision necessary to keep in good working order roving and ring frames. State fully the parts which require regular attention, the precautions needed to keep them working satisfactorily, and the chief points where wear or damage takes place.

A. In both machines every attention must be given to systematic and efficient oiling and cleaning of all the working parts, and the rollers and spindles especially require attention in this respect. On the ring frame the spindle bands must be of good quality, and put on at a regular tension. On the roving frame the cone belt must be kept in good condition, and on both machines care must be taken to have all the change wheels of correct size and all gearing properly in tooth. Worn studs, shallow gearing, etc., should especially be avoided in connection with the copping mechanism of the ring frame and the lifting mechanism of the roving frame. In each case the roller traverses must be kept right, and the rollers well set and properly weighted. The bobbins should in each case be doffed at the proper time, this being perhaps more important on the roving than on the ring frame. Binding of the lifter rail in each case must be avoided. In each case it is a great duty of the overlooker to see that the bobbins are correctly built and the cotton is of the proper counts, twist, etc.

RINGS.

Rings are rolled from solid steel without any weld, and made either double or single flanged, according to the requirements of the mill officials. Great care must be, and undoubtedly is, exercised in making them perfectly cylindrical. They are usually fixed in the ring rails in such a manner as to preserve the perfect circle, and each ring can be released without interfering with its neighbour. Although it seems a plausible argument that double-flanged rings should have double the life of single ones, owing to their capability of being reversed when one edge is worn, yet taking cleanliness and other considerations into account, the single flanged or non-reversible ring appears to give by far the most general satisfaction, in England at any rate.

Cleanliness is of course a most essential requisite in a ring frame.

It would appear, however, that in the United States—where ring spinning is far more popular than in England—the double ring meets with very considerable favour.

Probably the most common angles of the rollers are 15°, 20°, 25° and 35°. It is unlikely that much benefit results from greater angles than, say, 25° for any cottons.

THREAD-BOARDS.

There is a little difference of opinion as to whether the thread-boards should be made to slide lengthways or lift up out of the way. While the former are more rigid, some people consider the latter more convenient.

GEARING WHEELS.

These may be machine moulded or cut. There has been a strong tendency in recent years towards the use of cut gearing wheels for the various machines. Taking the case of the change pinions for counts, the author has undoubtedly had a great deal of trouble with cast wheels, and has found

HOWARD & BULLOUGH'S PRODUCTION TABLE FOR RING FRAMES.

Speed of Spindle per min		6,000 Revolutions.			7,000 Revolutions.			8,000 Revolutions.			9,000 Revolutions.			10,000 Revolutions.		
Counts of Yarn.	Turns per in.	Speed of inch dia. frt. Roller per minute.	Production per Spindle in ten hours.		Speed of inch dia. frt. Roller per minute.	Production per Spindle in ten hours.		Speed of inch dia. frt. Roller per minute.	Production per Spindle in ten hours.		Speed of inch dia. frt. Roller per minute.	Production per Spindle in ten hours.		Speed of inch dia. frt. Roller per minute.	Production per Spindle in ten hours.	
			Hanks.	Lb.		Hanks.	Lb.		Hanks.	Lb.		Hanks.	Lb.		Hanks.	Lb.
6	9·8	195	9·35	1·56												
8	11·3	169	9·2	1·15												
10	12·6	151	8·3	0·83	176	9·7	0·97									
12	13·9	137	7·6	0·631	160	8·88	0·74	183	10·1	0·845						
14	15·0	127	7·45	0·533	148	8·65	0·619	169	9·87	0·708						
16	16·0	119	6·96	0·435	140	8·2	0·513	160	9·36	0·587	180	10·55	0·658			
18	17·0	112	6·55	0·363	131	7·65	0·424	150	8·78	0·488	169	9·87	0·548			
20	17·9	107	6·25	0·312	125	7·3	0·362	142	8·3	0·416	160	9·35	0·466	178	10·3	0·516
22	18·8				119	6·97	0·317	135	7·9	0·359	152	8·9	0·405	169	9·9	0·450
24	19·6				114	6·68	0·278	130	7·6	0·317	146	8·65	0·36	163	9·62	0·402
26	20·4				110	6·44	0·248	125	7·31	0·282	140	8·2	0·315	156	9·12	0·352
28	21·2				105	6·15	0·22	120	7·02	0·251	135	7·9	0·282	150	8·77	0·314
30	22·0				101	5·9	0·196	116	6·8	0·227	130	7·6	0·254	145	8·49	0·283
32	22·6				99	5·8	0·182	113	6·61	0·207	127	7·44	0·233	141	8·25	0·258
34	23·3				96	5·61	0·165	109	6·38	0·187	123	7·2	0·212	136	7·95	0·234
36	24·0				93	5·44	0·152	106	6·2	0·172	119	6·96	0·194	132	7·72	0·215
38	24·7				91	5·32	0·14	103	6·04	0·159	116	6·78	0·178	129	7·55	0·199
40	25·3				88	5·14	0·129	100	5·85	0·146	113	6·62	0·166	126	7·37	0·183
42	26·5							96	5·61	0·134	108	6·32	0·151	120	7·05	0·167
44	27·1							94	5·50	0·125	106	6·2	0·141	117	6·85	0·156
46	27·8							92	5·37	0·117	103	6·03	0·131	115	6·73	0·147
48	28·4							90	5·26	0·110	101	5·91	0·123	112	6·55	0·136
50	29·0							88	5·14	0·106	99	5·8	0·116	110	6·44	0·129

cut pinions to run more smoothly. On the other hand, the cut pinions have not proved sufficiently durable in many cases, and the increasing perfection with which gearing wheels can be moulded appears to point towards the retention of cast wheels.

It is contended by some that cut wheels run better. On the other hand, there can be little doubt that moulded wheels are more durable. Machine moulded wheels can be made perfectly cylindrical, and also parallel throughout the full width of the teeth. To prevent possible irregularities, they are in many cases afterwards finished with special grinding machinery.

IMPROVED POKERS.

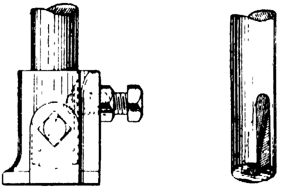

FIG. 16 (*a*).

Referring to Fig. 16 (*a*) this improvement allows of the pokers being readily removed for cleaning purposes; when replaced, owing to the special construction, no setting whatever is required, the poker foot immediately fitting to its place, thus saving time when the frames are being cleaned.

FINE COUNTS ON THE RING FRAME.[1]

There is a tendency towards the employment of the ring frame for the spinning of the finer counts, and a few cases exist where even Sea Islands yarns are spun on the ring frame. Very many cases exist in Lancashire of the spinning of medium fine yarns from Egyptian cotton. It is no very difficult matter to spin, say, a good 60's, 70's or even finer yarns on the ring frame providing a very good roving is given to the machine and the yarn is wound upon good bobbins. In the spinning of the best yarns in the ring frame combed rovings are often employed, and double roving may be regarded as a *sine qua non*.

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[1] At the present time (June, 1901) makers of fine mules are pushed to their utmost capacity to cope with the demand for fine-spinning mules in the Bolton district, while comparatively few ring frames are being put in for fine and medium fine.

Many people find considerable benefit from the application of humidifiers in their ring spinning rooms for the spinning of fine counts. One of the reasons for this is that improved atmosphere has sensibly diminished the number of fainting cases amongst the women tenters.

In the spinning of fine counts it is also found advantageous to have the difference of diameter between bobbins and rings as little as convenient, assistance being rendered in this direction by the thinnest of the fine yarn enabling a good length of yarn to be wound into a limited space.

It is well known that the inclination of the roller stands on a ring frame greatly improves the spinning by enabling the twist to run right up to the nip of the rollers.

This inclination is very usually about 25°, but may be anything from about 15° to 35°, while cases exist where even these limits are exceeded.

It will be understood that the spinning of fine counts is generally considered to require a good deal of inclination.

Bobbins.

Wilson Bros. make a serrated shield, which they claim will make it practically impossible for the shields to come loose. These shields are made with spikes, *i.e.*, they are serrated on the inner edge, and these serrations or spikes are pressed into the wood of the bobbins, rendering them secure under almost all circumstances. The author must, however, here remind readers that there are yet many mills which use mostly bobbins or tubes which are quite plain, and neither have headings nor protectors.

FLANGE WINDING AND WARPERS' BOBBINS.

Many of our practical readers are well aware that often there is much trouble and loss owing to the frequent breakages of the flanges of the flanged bobbins often used in connection with winding, warping, gassing and other frames.

The above firm made a patent flange binder. This is a narrow fluted steel ring, which necessarily strengthens the flanges to an enormous extent, and although these steel rings necessarily add to the first cost, it is a great question whether the extra cost is not fully met by the longer life and greater usefulness of the bobbins. The writer has handled and used such bobbins, and can testify to their great strength. Another speciality in this connection is the patent endless steel tyre, which has the additional recommendations that it renders the periphery of the flange perfectly smooth. It is made with a double edge of metal on the inner edge of the flange.

Bobbins for Ring Frames.

It is well known that for a good number of years now ring spinning has been receiving a good deal of attention and adoption in this country. The tendency towards increased speeds and the desire for increased quality has rendered the production of perfectly accurate bobbins an absolute necessity. Wilson Bros. make the Cornholme shield. This shield is made with a double or folded over edge, which is pressed into the wood, thus giving a smooth point and great strength to resist crushing strain.

In consequence of the introduction of conditioning yarn on the bobbin, the difficulties of maintaining the bobbins perfectly true have been vastly enhanced, and to the author's positive knowledge this has been a great source of trouble and anxiety to many overlookers of ring frames.

These difficulties have rendered it necessary to introduce bobbins more able to resist the effects of moisture than those formerly in use.

In 1889 Messrs. Wilson recognised this difficulty so fully that they put down a special plant for the enamelling of wood bobbins, and this new departure has proved so successful that the enamelling department has had to be increased, and the enamelled bobbins are in very extensive use in all parts of the world.

CHAPTER III.

DOUBLING AND WINDING.

THE TWINER

Q. 1896. Describe generally the action of the twiner, and say in what principal respects it differs from the mule.

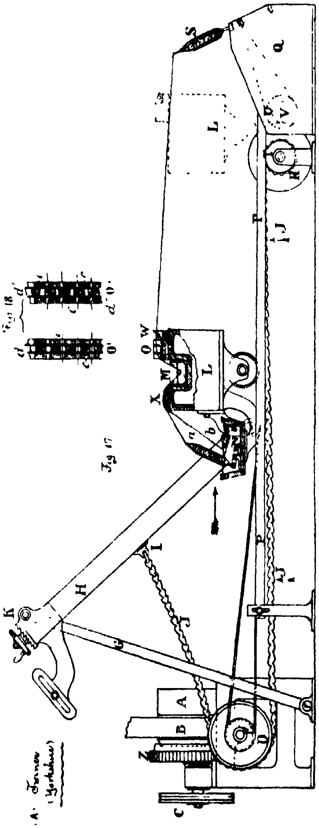
A. In its main features the action of a twiner jenny bears a close resemblance to the action of a spinning mule. Any spinner who thoroughly understands the mechanism of a self-actor spinning mule would have little difficulty in understanding the mechanism of a twiner jenny by the same makers. The chief differences between the two arise from the fact that there are no drawing rollers in the twiner, and the creel has to be constructed to hold cops instead of roving frame bobbins. It is therefore the most convenient plan to allow the creel to travel and the spindle carriage to be stationary, and this arrangement is usually adopted instead of having the carriage to travel, as in the spinning mule. In place of the drawing rollers there is a slide bar arrangement which allows the threads to pass freely through during the operation of twisting, and during backing-off and running-up is locked so as to prevent the yarn from leaving the cops at these periods. The creel is generally arranged so that the yarn is pulled over the cop noses first, but when perhaps three-quarters of the yarn is pulled from the cops the latter are changed to a position in which the skewers revolve and the yarn is pulled from them like roving from bobbins. The skewering of cops is a frequently recurring operation which adds greatly to the work of twiner operatives. Usually two ends are doubled and twisted together at the twiner, and occasionally three ends and sometimes two of the doubled threads are put together again so as to make, say, fourfold. The higher doublings, however, are more frequently done with the doubling, winding, and the ring doubling frames. There is a considerable amount of twining done in Yorkshire, and a Stockport master doubler complained to the author that the Yorkshire master twiners seem to be able to double cheaper than he could afford to do on his ring doubling frames. In the twiner jenny there is a backing-off and faller-wire arrangement similar to the spinning mule. The copping rail is usually short, and is made to travel by means of connecting rods from the quadrant. There may be a water trough for the ends to pass through water, or it may be dry doubling. Before twining the single yarn is often placed in a steam chest for some time in order to solidify the thread and to stop it from curling and snarling and chopping down. The threads are drawn over flannel-covered surfaces in order to put a kind of drag or tension on them.

Q. 1900. Describe the operation of twining. What are the advantages obtained, if any, over other systems of doubling when adopted for the production of doubled warps? How does this machine compare as to amount of production with other machines?

A. The twiner is very largely used for the doubling and twisting together of twofolds, and occasionally for higher doublings.

This machine is to all intents and purposes a self-actor spinning mule, excepting that the drawing rollers and attendant mechanism are not used. Occasionally old spinning mules are converted into twiners, and the twisting spindles are traversed about with the carriage. More frequently the creel is made to traverse, and the twisting spindles are fixed in a stationary carriage, as this is found to be the most convenient. During backing-off and winding-on the threads are prevented from pulling off the creel cops or bobbins by a thread locking slide motion, which should hold each thread firmly without damaging it. On a twiner doubling twofolds two threads go together over a flannel-covered drag board, through a water trough, over another drag board, and then on to the twisting spindle.

Taken altogether, it is a great question as to which is the better practice even for twofolds—whether to use the twiner or the ring doubler. The flyer throstle doubler is now discontinued, except for some specialities in very coarse and very fine yarns.



FIGS. 17 and 18.

On a twiner it is easier to humour the twist, and it is possible to spin the yarn on cops, and thus save the cost and trouble of bobbins. The expense also of the doubling winding frame may be saved, and the doubled thread may be a little more elastic. As regards production, the twiner may be said to come between the flyer and ring throstle doubling frames.

It can be more readily adapted to a wide range of counts than the other systems.

The yarn from it when used for warps probably gives a softer and fuller appearance to the cloth.

Figs. 17 and 18 are designed to illustrate the action of the twiner. A, B are the fast and loose pulleys of the headstock; C is the rim pulley; Z is the large backing-off friction cone wheel; D is the large guide pulley for the long winding chain, J; F is the fulcrum of the long guide bar or rod, G, used instead of the quadrant to give motion to the radial arm, H.

Referring now to the parts in or near the stationary carriage. Q is the spindle band; R is the large winding drum wheel, gearing with U on the tin roller, V; T is the winding drum; S is the cop of doubled yarn; P is the rail or slip upon which the carriage, L, moves backwards and forwards.

Referring now to the movable carriage. L, shown midway between its extreme positions. *a*, *b* are the two cops of single yarn, one of which is shown a little inclined from the vertical, and the other almost horizontal, both positions being more or less used, the first for full cops and the second position more especially for the cops when most of the yarn is wound off.

Passage of Yarn.

The two threads from the cops, *a*, *b*, are passed over the flannel-covered drag-board, X, and together beneath the glass rod or hook in the water trough, M, between the brass locking slide, O, over the drag-board or rod at W, and on to the doubled cop at S.

Thread-locking Motion.

This is shown separately in Fig. 18. At O^1 the threads are shown passing freely through the brass snugs, *c*, *d*, while at O_2 they are shown locked ready for backing-off and winding-on. The middle brass rod, *d'*, containing the locking snugs, is made to slide into position, O_2, when the carriage gets out, thus locking all the threads.

SYSTEMS OF RING DOUBLING.

Q. 1899. What are the English and Scotch systems of doubling? Describe the differences existing in the machines, sketching the parts specially used in each system.

A. The English doubler has the rollers carried on stands fixed to the roller beam, but the rollers are not in the water at all. There is a glass rod placed in the water trough, under which each thread passes before reaching the rollers. A recent addition to this system consists in facilitating the raising of the glass rod out of the water for cleansing and other purposes. Each thread passes from its creel bobbin, under the glass rod, under and half round the bottom brass roller, over the top roller, and then down to the twisting spindle. In the Scotch system of doubling, the threads pass first beneath the rollers and then between them, and the bottom one of the pair is placed adjustably in the water. The threads are usually kept longer under the water in the Scotch system than in the English. The principal difference, then, between the two systems will be found in the size and shape of the water trough and the position of the guide rollers. There are no draft rollers in either system.

The accompanying Figs. 19 and 20 admirably illustrate the different systems of doubling, and are practically self-explanatory, the passage of the yarn from creel bobbin to twisted doubling bobbin being clearly shown.

The several methods of making doubled yarns, of which four arrangements are shown in Figs. 19 and 20, and the large range of counts, say from 4's to 120's, to double from, necessitate the making of these machines of a variety of gauges with different sizes and shapes of creels, spindles and bobbins. To refer briefly to these several points, we may mention that the system of doubling in the best threadmaking establishments is to wind by means of stop motion doubling winders, 2, 3 or 4 ends from ring frame bobbins on to warpers' bobbins, which, when full, are placed on the ring doubler creel; one bobbin supplying one doubling spindle with yarn to have the necessary twist put in; thus a twisted thread is produced comprising 2, 3 or 4 strands. This is the general method for making average qualities of thread, etc., but when the better sorts are required "cabling" is adopted, *i.e.*, a repetition of the winding and doubling processes just referred to, but with the twisted threads this time, therefore the ultimate doublings would be of 4, 9 or 16 strands respectively. Of

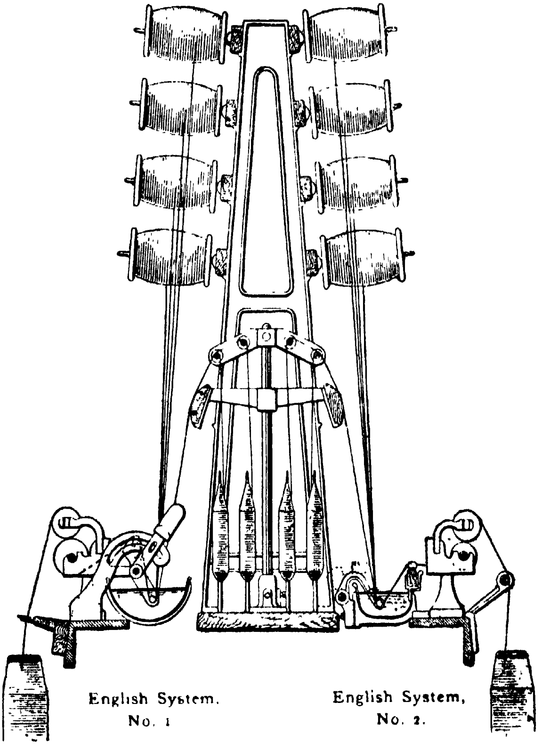


Fig. 19.

course different combinations of the strands may be made, thus four three-stranded threads cabled would be 12 folds. The use of the doubling winding frame is to prevent " single," for when an end breaks the self-acting stop motion comes in operation and stops the warper's bobbin, when the winder can make the necessary reparation. For occasional purposes, where quality or quantity is not an important consideration, doubling and twisting are done at one operation on the ring doubling frame, for which purpose a creel is employed, suggestive of and known as the porcupine, where warper's bobbins containing single yarn are placed in heights, so that several ends, up to six in some instances, run to one spindle to be twisted together. This is considered by some to be rather an objectionable and inconvenient method, because the

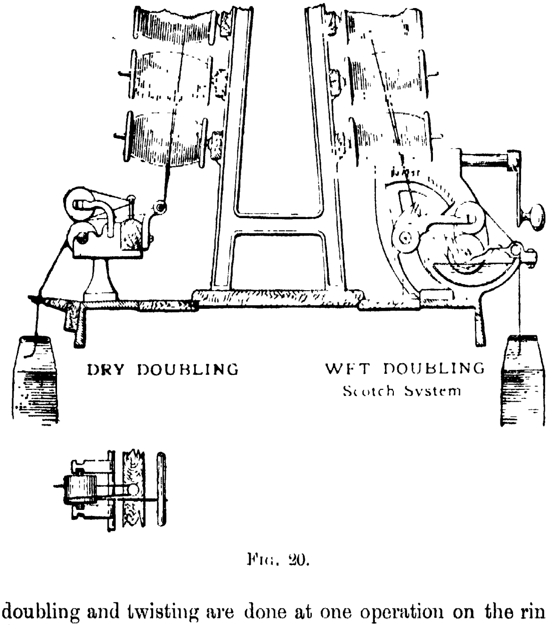


FIG. 20.

creel becomes too high for economical working, the hands not being able to replace the bobbins easily, and a stop-motion not being applied usually to the machine, irregular thread is made owing to ends breaking and escaping the attention of the minders until a considerable length has been twisted and irreparable mischief done. Other arrangements of creels and methods are employed, but those mentioned are mostly called for. As regards gauges these generally commence at 2¼ inches for the very fine thread, and they rise in six advances up to four inches gauge, which latter is used for making very strong thread, heald yarn, fine cord, etc., the intermediate gauges being used chiefly for the numerous qualities of thread, crochet yarn and special work. In the fine gauge frames a light running 5-inch lift spindle is used, and in the intermediate gauges generally a 6-inch lift. It may be stated that there are twisting machines with stop motions, one of which is shown in Fig. 21.

DOUBLING SPINDLES.

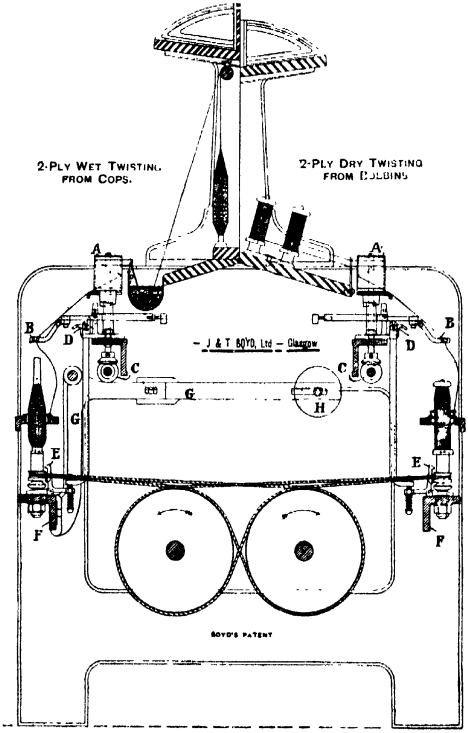
There are several points that are necessary in a good spindle, and a few might be mentioned:—

1. Light running.
2. Steadiness under high speed, which is tested by running with unbalanced bobbins.
3. Simplicity of construction.
4. Non-liability to get out of order.
5. Capability of running for lengthened periods of time without cleaning, lubrication or other attention.
6. And, as important as any, cheapness.

Knee Brake.—For heavy doubling, when specially ordered, an improved and patented knee brake is applied, enabling the attendant to stop any spindle with a little pressure of the knee. For the finer gauge frames, and frequently for coarse gauges, the knee brake is not essential, and the wider wharve on spindle is recommended, which amply serves for stopping the spindle.

DOUBLING AND TWISTING.

Fig. 21 shows a system of simultaneous twisting and doubling, of which the following is a description :—


2-PLY WET TWISTING FROM COPS.
2-PLY DRY TWISTING FROM BOBBINS
A
A
B
B
D
D
C
C
G
G
H
E
E
F
F
— J & T BOYD, Ltd — Glasgow
BOYD'S PATENT

SHOWN WITH SWINGING RAIL. SHOWN WITH FIXED RAIL.

FIG. 21.

Twisting direct from Cops or Bobbins (without winding).—The two yarns are carried around the leather-covered delivery roller, A, over the balanced lever, B, to the twisting bobbin. When one yarn fails the other unspins and allows the lever, B, to rise at its front end until the upright part on B comes into the path of the cam formed on under side of the delivery roller, A. The delivery roller, acting on B by its own revolution, draws itself out of gear with the bevel pinion, C, and stops, thus waste and laps are prevented. When the end has to be pieced, the worker, by means of the lever, D, puts the break, E, on the spindle. She then depresses the lever B, which carries the lever D along with it, thus starting the delivery roller and the spindle simultaneously.

The fibre of each yarn is wrapped round itself before the two yarns are twisted together. This is done by the downward rubbing of the yarn on the leather-covered delivery roller on its passage to the lever B, thus making smoother yarn.

Band Tensioning. The bands before being put on are stretched with a given weight, and there are printed on them two marks indicating where the knot must be, in that way ensuring all bands are of equal length. The spindle rails, F, are made in sections, about five feet long, and instead of being fixed to the framing may be carried on swing levers, G, which, by means of the weights, H, press the rails outwards and give all the bands a continuous tension. This arrangement maintains the fixed minimum driving power decided upon for the spindles, and greatly reduces the total power required for a frame, particularly in damp weather.

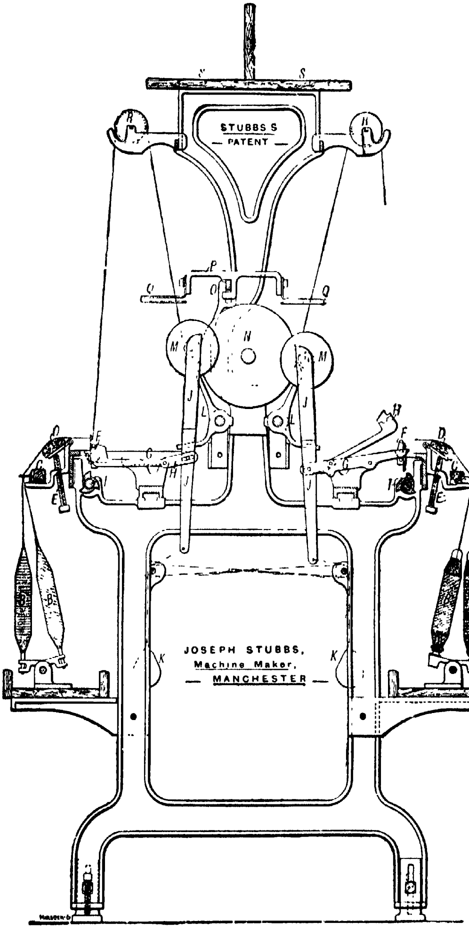
When yarns are required above two ply they can be double wound on bobbins or cheeses and twisted on the above frame, with the advantage that roller laps will be entirely prevented and all the waste in front of the feed rollers saved.

Q. 1896. Describe the process of doubling winding, and say what advantage is obtained by cross winding.

A. A doubling winding frame may be a single drum machine or a double drum machine, and may have a quick traverse or a slow traverse. In the latter flange bobbins are used, but in the quick traverse drum winding machine the "cheeses" are formed upon a spindle without flanges to keep the edges good. In this machine the cops or ring bobbins are placed in a creel at the front and lower part of the machine. The threads are conducted through guide holes over an adjustable, flannel-covered drag-board, through detector wires, upwards over a small wooden guide roller, and downwards again, when two or more threads are wound together on the same bobbin. Each thread passes through a separate detector wire, and when the thread breaks the wire falls and sets in motion mechanism by which the particular bobbin upon which the broken thread was passing is swivelled out of contact with the driving drum. Simultaneously a break is brought against the cheese, causing instantaneous stoppage of the bobbin, and preventing "single" from passing thereon. In this facility for preventing "single," combined with a like prevention of "cork-screwed" yarn, lies the great merit of this process. Of course, it is well known that by "cork-screwed" yarn is meant the twisting and doubling together of threads of uneven tension, whereby the slack thread becomes in a manner coiled round the tight thread, and the latter has to sustain all the strain. "Cork-screwed" yarn is of no use when it is used for thread which has to pass through the eye of a needle.

The latter part of the question asks what advantage is obtained by cross winding. By giving a very rapid horizontal traverse to the threads in a quick traverse drum winding frame the yarn is cross wound upon the cheeses in exceedingly open coils, and this causes the cheeses to be very solidly and firmly built up. Also the threads dwell such a small time at the edges of the cheeses that flanged bobbins can be dispensed with, which is a great advantage for transit purposes. Some of these machines are noisy, and there is frequently a tendency for the cheeses to run off at the edges in spite of the quick traverse. As regards both these points there is yet room for the ingenuity of inventors.

Fig. 22 is a diagrammatic view of a well-known make of doubling winding frame, using flanged bobbins, **M**, driven by frictional contact with the drum, N. It is a single drum winding frame.


S
S
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STUBBS S
PATENT
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D
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F
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G
H
H
C
C
E
E
I
I
B
B
K
K
JOSEPH STUBBS,
Machine Maker,
MANCHESTER
A
A

Fig. 22.

Reference Letters to Fig. 22.

A Cop Box.
B Cops or Ring Throstle Bobbins.
C Wire Rail.
D Adjustable Drag Rail.
E Adjusting Screw for Drag Rail.
F Detector Box.
G Frame for carrying Detector Box.
H Setting-on Handle.
I Ratchet Shaft.
J Bobbin Cradle.
K Weight for Bobbin Cradle.
L Brake for stopping Bobbin.
M Winding Bobbin.
N Bobbin Drum.
O Traverse Rail.
P Guide Bracket.
Q Thread Guide.
R Wood Roller.
S Bobbin or Cop Box.

Fig. 22 (*a*) is a general view of an excellent double drum quick traverse winding frame as made by Messrs. Dobson & Barlow.

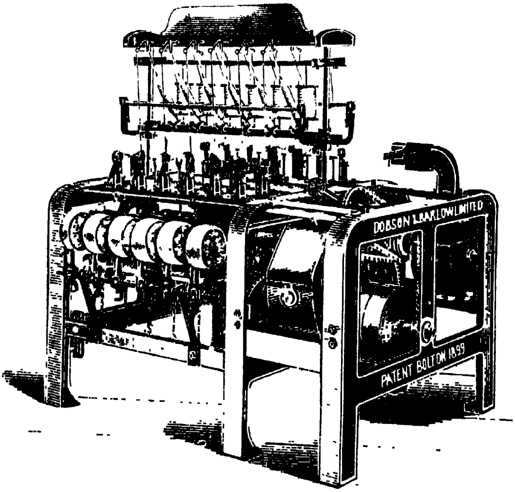

Fig. 22 (*a*).

Q. 1898. State what you know of the various systems of winding doubled yarn or threads: (1) For twisting, (2) for delivery to the user. Distinguish between them clearly.

A. Yarns spun on the ring frame more especially are now often wound upon cheeses on the quick traverse drum winding frame; this being an economical and ready method of putting these yarns into convenient form for transit purposes,

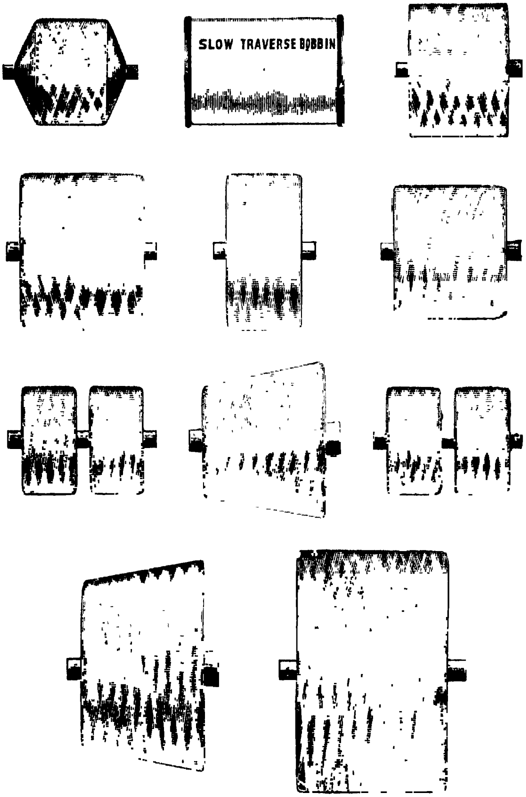

FIG. 23.

instead of being at the trouble and expense involved in the carriage of ring frame bobbins. Although bobbins may be used at the drum-winding frame, yet they need not contain flanges, and such a large amount of yarn can be quickly put upon one single bobbin that the expense is very low. The system of rapid cross winding allows of the building up of a firm cheese, without running off at the edges.

Although the same machine may be used when the yarn has to be doubled, yet two or more ends in this latter case are invariably put together, and a single preventor stop motion must be used. The ordinary vertical spindle winding frame, or the drum winding frame, with slow traverse may be sometimes used to prepare yarns for the warping machine when it is intended to sell yarn in the form of warps. The twiner, of course, converts the spun cops of single yarn into larger cops of double yarn, at the same time twisting the single threads together, so as to form a doubled thread.

The question appears to us a little ambiguous, as we are not aware that it is usual to wind doubled yarns for twisting, except, perhaps, in re-winding on the doubling winding frame in preparation for the finisher doubling frame. Doubled yarns are sometimes passed through the winding clearer frame to clean and rid them of knots and irregularities.

Various kinds of bobbins as made on doubling winding frames are shown in Fig. 23.

Vertical Spindle Winding Frames.

Figs. 24, 25 and 26 are diagrammatic views of three systems of vertical spindle winding frame as extensively used for the winding of single yarns.

In each case A is the bobbin from the ring frame or cop from the mule; B is a brush in one case, and flannel-covered drag-board in other cases, as shown, its use being to tension and clean the yarn.

At C or D the yarn is guided to the bobbin, while E, F or D are the bobbins as made ready for the warper's creel.

The spindle wharves at G, H (Fig. 24) are made larger for the back row than for the front row, and the bobbins, when perhaps one-half to three-quarters full, are transferred from front to back rows to prevent too high a winding speed of the yarn. I is the tin roller or cylinder.

THE "UNIVERSAL" WINDING SYSTEM.

This system of winding, which has been in practical use in the United States of America several years, appears to be extending in other countries.

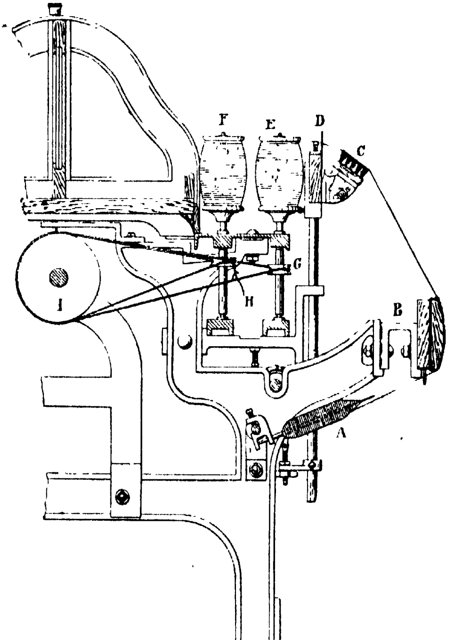

FIG. 24.

The machines are adapted for winding fibrous material of all kinds—twines, cords, linen, worsted, woollen, silk or cotton threads or yarns into cops or packages, either cylindrical or conical, varying in size from the smallest shuttle cops for sewing machines to those weighing 50 lb.

In winding by the " universal " or Leeson's process the thread or yarn runs over a guide in a straight line direct to the tube,

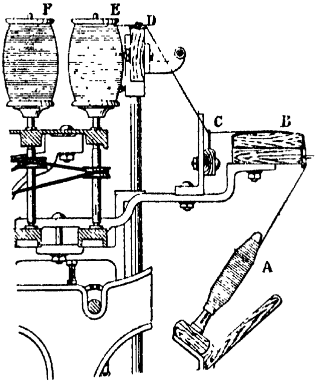

FIG. 25.

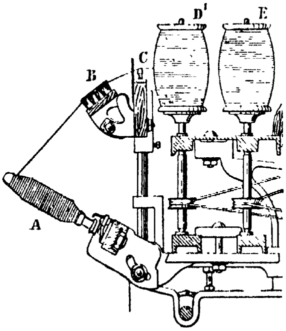

FIG. 26.

and the coils are laid side by side touching each other, but without over-riding or crushing. Each layer is exactly similar to the preceding one, consequently each is laid upon a firm supporting surface, without spaces, and the material is maintained in perfect condition without crushing or impairing the twist. As the coils do not often pass across the end of the cop, the thread can be drawn off the periphery of the cop over the end without catching or increasing the tension, thereby giving good results in delivery to high-speed machines.

An inexpensive paper tube is substituted for the ordinary spools or bobbins, and as the thread is laid upon the tube in such a manner as to be self-supporting, it does not require end flanges such as are sometimes used in ordinary thread winding. The expense of spools is thus dispensed with, and at the same time a saving in bulk of packages is thus secured. The machines themselves appear to be expensive in first cost

CHAPTER IV.

REELING, BUNDLING AND GASSING.

Reeling and Bundling.

Q. 1896. Why is yarn reeled and bundled, and for what purpose is it cross reeled? Show by a sketch the disposition of the yarn in seven leas and crossed hanks.

A. Yarn is reeled and bundled very largely for export purposes. In this way much yarn both from mules and ring frames is prepared for export. Particularly in the case of ring yarn spun upon spools or bobbins is this system advantageous. Instead of being at the expense of paying for the weight of the bobbins during transit, it is obviously a great boon to ring spinners to be able to pay the comparatively small expense of reeling and bundling. Both these processes are of the simplest character, and the first cost in the machines is small. In reeling for bundling and shipping purposes it is the usual plan to wind a hank of 840 yards upon the reel from each cop or bobbin, and to have the hank disposed upon the reel in parallel layers divided into seven parts, each division containing a lea or 120 yards. The reel is 54 inches or 1½ yards in circumference. The hanks being reeled, they are made up into bundles of 5 lb. or 10 lb. each, and are compressed into a solid compass in the bundling press. In this form the cost of transit is small, and the yarn when arrived at its destination can readily be wound upon bobbins and utilised for weaving purposes if required.

Cross reeling is carried out when it is intended to dye or bleach the yarn. In this form the yarn is left in a somewhat open condition, and, therefore, can take dye better, and is at the same time more easily unwound without entanglement. Cross winding is obtained by a swift backwards and forwards movement being imparted to the thread guide rail by a crank or eccentric.

Figs. 27 and 28 are intended to illustrate the more important details about ordinary reels. Fig. 27 shows the arrangement for open or 7-lea reeling, there being two portions of hanks of yarn shown on the reel staves, C. O, P are the pulleys by which the machine is driven. At A is a worm on the reel shaft which rotates the 80-worm wheel, E. F is a finger carried by the worm wheel, and, when the latter has made one revolution, F lifts stepped rack ladder shown up one tooth. The spring, S, always keeps the guide bar stud at M

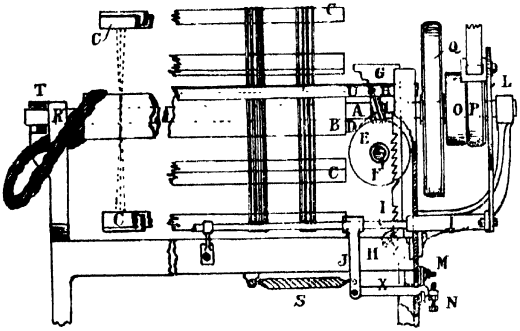

FIG. 27.

pressing against the stepped ladder, G. When the latter is lifted by the stud, F, the guide bar is moved lengthways against the next lower rung of the stepped rack, G, thus causing the yarn to be laid in a different position on the reel. On the left is shown the reel, C, closed for doffing, with the yarn just being taken off the reel end.

Fig. 28 shows the arrangement for cross reeling. In this case the spring, S, the 80-worm wheel, E, and the stepped rack, G, are not used, although they might be on the frame ready for use if required.

In their place the small bevel, E, is driven by the belt, D, and gives motion to the bevel, F. On the other end of same cross shaft is the crank or disc, G, carrying the stud, M, which in its rotation gives a continuous oscillatory motion to the guide rail, V. In this way the threads are crossed over each other instead of being laid parallel as in open reeling.

A is the reel shaft, B is the reel shell, and O, P the driving pulleys. In this case also the yarn is shown almost doffed at the left hand portion of the sketch. By a push across the rests, T, R, in the direction indicated by the arrow, the threads will be freed ready for taking off.

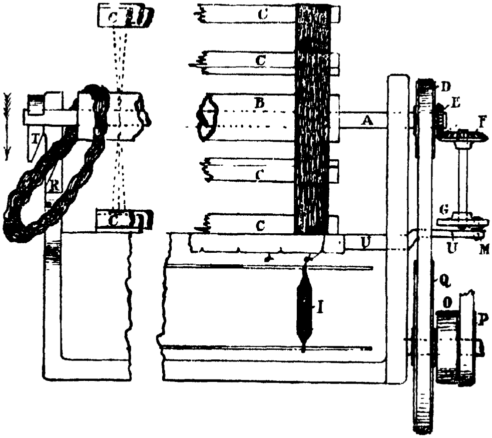

Fig. 28.

Q. What is meant in the bundle trade by the terms 7-lea, 6-lea, and double-crossed hank?

A. Reeling is mostly "open" or "crossed". Another common name for "open" reeling is 7-lea reeling, and in this case after a lea of 120 yards has been wound on the reel from each cop or bobbin the traverse bar or guide bar is moved longitudinally, so as to place the second lea a slight distance from the first, and so on with the seven leas that form the hank. The spaces permit the tieing up to be done, so that each lea is kept separate. Six-lea reeling is not very common, and means that six leas are taken as forming the hank instead of the usual seven leas.

Open reeling is common when the process is done for bundling purposes, or as a convenience for transit and other purposes, and is the method almost always employed with yarns for the Eastern markets.

In cross reeling instead of a hank of yarn being wound into seven more or less separate leas, the traverse bar is moved backwards and forwards continuously so as to wind all the hank with the eighty threads crossed over one another.

In the case of double crossed hanks, there are two hanks reeled together in this manner before doffing.

Cross reeling is generally done when the yarn is intended for bleaching and dyeing purposes, as it allows the dye stuff to get to the threads better and more uniformly than "open" reeling.

In addition it may facilitate the finding of broken threads.

In most reels it is a very easy matter to change from the one kind of reeling to the other.

Often crossed reeled yarns are made into long bundles, without being pressed, while the open reeled hanks are usually made into short bundles and subjected to heavy pressure in a powerful bundling press.

Q. What is the best method of removing the hanks from a reel with the least risk of marking the yarn with oil or dirt?

A. When doffing the hanks from a reel it was formerly a common practice for the reeler to lift the reel with one hand, while with the other hand the hanks of yarn were drawn off the reel.

Doffing is of frequent recurrence on a reel, and—especially in the case of coarse counts—the weight of a full reel is considerable, so that the strain becomes great for the women and girl reelers. In removing the hanks also it is requisite to take them very close to the oiled end bearing of the reel shaft, and in this way much yarn at times has been marked with dirty oil.

Great assistance is rendered in the removal of the hanks by means of "drop" or "collapsing" motions, by which the reel is closed up so as to loosen the hanks.

The question more particularly refers to "doffing" motions, of which there are several makes, the main object of each one being to obviate the necessity for the reeler having to lift the reel up.

There are the "gate," the "wheel," the "bridge," and the "parallel," or "inside" and "outside" motions.

In the "gate" motion the reel end is sustained in a bearing formed in a kind of gate working on hinges, and the gate is opened for doffing purposes, thus leaving a free passage for the yarn. This motion is very effective, but is clumsy, partly due to the necessity for having a support for the reel, arranged so that it is out of the way when working, but supports the reel when the gate bearing is removed for doffing.

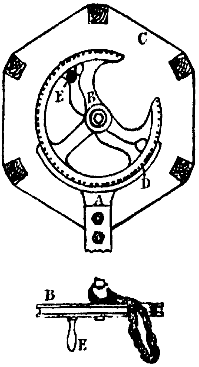

FIG. 29.

Fig. 29 shows the wheel doffing motion. A, D is the rest for the wheel, B; C is the reel; E is the handle. A hank of yarn is shown almost doffed.

In the "wheel" motion the end of the reel is sustained in a "doffing wheel," which consists of a wheel with a segment absent, that is to say, a kind of broken wheel. The hanks having been drawn to the reel end are passed into the "open" portions of the wheel, and, by giving a slight turn to the wheel, the hanks are freed from the reel end.

Fig. 30 is a slight sketch of the "bridge" motion, with a hank of yarn ready for removal.

The "bridge" motion is one of the most recent and best known of these motions. A gap is formed in the end of the frame, and a slotted bracket termed the "bridge" is used in order to reach across this gap. The bridge during working rests on one end, and during doffing on the other end, while during the horizontal crossing of the reel end it is momentarily horizontal, so as to bridge the gap. A moderate push against the reel is sufficient to force the bridge into any position, and at all times the bridge is supporting the end of the reel. The hanks are partially doffed, and then the reel is pushed smartly across the bridge, thus freeing the other side of the hanks and allowing of their ready removal. The bearings for the reel are carefully constructed, so as to allow of satisfactory lubrication, with the minimum amount of risk of oil getting on the yarn.

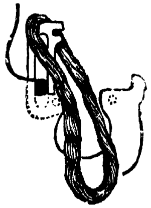

FIG. 30.

In the "parallel" doffing motion, shown previously, which has some points of resemblance to the "bridge," there are two possible supports for the doffing end of the reel shaft. One support is inside or nearer to the reel than the other, and is to hold the reel during doffing, while the outside bearing is for the reel during working. As in the case of the bridge, the hanks are partially removed, and then the reel is smartly pushed across from the outside to the inside bearing, thus freeing the hanks and allowing of their ready removal. This is the simplest motion of all. The bearing on which the doffing end of the reel rests during working is composed of a special metal supposed to do without oiling. In some cases brass bearings have holes drilled through, and the holes are filled with black lead under hydraulic pressure.

Q. 1901. Describe the process of reeling. How and in what lengths are the hanks wound for delivery (*a*) in this country, (*b*) in France, (*c*) for re-winding, (*d*) for bleaching? Say how the hanks are tied.

A. The process of reeling itself is dealt with in previous answers. For delivery in this country it is a common practice to reel the yarn into hanks of 840 yards each. Sometimes double hanks of 1,680 yards are wound. Below is given a much fuller comparison of the French and English systems than the question calls for. By the English system of numbering yarns is understood the number of hanks of 840 yards each which go to make a pound of 7,000 grains. So largely has the cotton spinning industry been ruled by England that the English system of numbering yarns is in almost universal use throughout Germany and Switzerland. In France, however, the counts or numbers of yarns are based on the metric system. In this case the metre of 39·37 inches is the standard of length, and the kilogramme of 2·2047 lb. is the standard of weight.

In numbering cotton yarn a thread of yarn 1,000 metres long, weighing 500 grammes (half a kilogramme), is taken as No. 1, so that—

2's yarn in French = 2,000 metres, weighing 500 grammes
4's ,, ,, ,, = 4,000 ,, ,, ,, ,,
20's ,, ,, ,, = 20,000 ,, ,, ,, ,,
60's ,, ,, ,, = 60,000 ,, ,, ,, ,,

The French number = 0·847 × English number.
The English number = 1·18 × French number.

The length of 1,000 metres is termed a hank (or *écheveau*), and each hank is divided into 10 skeins, the latter being therefore 100 metres each. These skeins are wound on a reel of 56·122 inches circumference as against the standard of 54 inches for the English system. 56·122 inches = 1·425 metres. The counts equal the number of hanks required to weigh 500 grammes. A working rule is to divide the metres reeled by twice the weight in grammes equals counts French. To reduce French counts to English we may multiply the French yarn counts by 1·18.

To reduce English to French counts we may divide the English counts by 1·18.

For many years attempts have been made to introduce a uniform system of numbering yarns. In the metric system the number of a cotton yarn indicates the number of times 1,000 metres (1093·63 yards) or $^{m}/_{m}$ required to make a standard weight of 500 grammes (1·102 lb.). The product of the weight and number is always the same, that is, 500. The number of the yarn is obtained by dividing the length by twice the weight.

Example: What is the counts of a thread, 60 metres of which weigh 5 grammes?

$$\frac{60}{2 \times 5} = 6.$$

For bleaching purposes it is usual to cross reel the yarn into hanks.

Making Up.

Q. 1898. Yarn is exported in various forms. State what you know of the different methods of making it up for shipment, and give full particulars of its preparation in bundles.

A. A good deal of yarn is exported in the form of cops spun upon mules. Some of this is packed in boxes and some in casks. The casks will hold a considerable quantity of cops and stand a lot of knocking about without damage, but they are awkward to pack. Of late years it would appear that the tendency has been to favour packing in boxes or cases specially made of a cheap and flimsy character, so that they need not be returned when empty. Packing cops in this manner is not much trouble, although, of course, care should always be exercised that the cops are not damaged, the boxes being lined with paper. A fair amount of yarn spun upon ring frame bobbins is cross wound into cheeses upon the doubling winding frame, and exported in this form. A considerable portion of yarn is reeled and bundled, both spun on the self-actor mule and upon the ring frame, this being an old-established and very convenient form of exporting yarn. A good deal, of course, depends upon what the yarn is intended for abroad as to whether it must be packed in the cop or bundle form. Suppose, for instance, pin cop weft be bought for placing in the shuttles of the foreign looms without dyeing or other preliminary process whatsoever, it would obviously be best to pack such yarn in the cop form. When yarn is intended to be bundled it is first wound into hanks upon the reel, where it may be cross-reeled or 7-lea or open reeled. The cops being put upon skewers, the threads are attached to the reel, and the latter revolved until, say, one hank, or 840 yards, is unwound from each cop. The hanks are then properly tied and the reel closed up so as to allow of the hanks being withdrawn. Afterwards the hanks are made into knots and placed on the table of the bundling press, so as to make a bundle of 5, 7½ or 10 lb. weight, the latter being the most common weight. The number of hanks in a 10 lb. bundle clearly will depend upon the counts of the spun yarn. For instance, a 10 lb. bundle of 40's would contain 400 hanks, and one of 50's would contain 500 hanks. A press is usually arranged so that the bundle can be tied up with four strings, and often special paper and tie-up string are used, the details of a make-up being varied to meet the requirements of customers.

Q. Define exactly what is meant by the following particulars given with an order for bundle yarn, taking them in the same order as given: 10 lb. net, 40's, 36 lb. test, Grandrelle, 20 hank halshed 8, blue facing, backs, no type stamp, black press twine, full length. Say how many heads of knots would show at the end of the bundle.

A. It is the most usual practice to make bundles of 10 lb. weight, but sometimes 5 lb. bundles are made; and while it is customary to make presses for 10 lb. bundles, it is also usual to supply lining blocks for the yarn box for the purpose of reducing its size to suit 5 lb. bundles Occasionally 7½ lb. bundles are made.

In the case given there must be 10 lb. net weight of yarn apart from packings or banding. The yarn must be 40's counts, and a lea or 80 threads must pull to a minimum of 36 lb. on the strength testing machine. Grandrelle tieing-up thread for the hanks must be used, the thread being composed of two or three colours of yarn doubled together. 20 hank halshed 8 means that 20 hanks are halshed together by a figure of 8 knot, so that 10 hanks will be in each loop of the figure 8.

Blue facing means that a piece of blue paper must be placed at that end of the yarn box nearest the maker-up, and where the hard ends of the knots are, being held in position by being passed under the backing paper and tied.

"Backs" consist of very stiff paper or a kind of cardboard being placed on the top and bottom of the bundle and tied up with the string.

No type stamp means that the counts or identification marks should not be stamped on the bundle. Black press twine means that the four strings used to tie up the bundle while in the press, and before the wrappers are put on, should be black in colour.

Full length means that every lea should contain 120 yards and every hank contain 840 yards.

Each knot contains 10 × 2 = 20 hanks, and there must be 10 lb. × 40's counts = 400 hanks in the bundle; so that we shall have 400 ÷ 20 = 20 heads of knots showing at the face of the bundle.

It will be noticed that by having a 10 lb. bundle we need only to add a cypher to the counts to find the number of hanks in the bundle. Thus with 10's yarn there would be 10 × 10 = 100 hanks in the 10 lb. bundle; with 60's counts there would be 60 × 10 = 600 hanks; with 20's counts there would be 20 × 10 = 200 hanks; and so on.

Q. Briefly describe the operation of bundling and the machine used.

A. A bundling press consists of the yarn-box, the movable table on which the yarn is laid inside the yarn-box, and the requisite mechanism for giving the proper motion to the table. The use of the machine is to press a suitable quantity of yarn into a compact bundle, 10 lb. being the most usual weight taken.

The yarn-box is formed by a series of strong bars projecting upwards on each of two opposite sides of the machine. Between each pair of bars space is left for a tieing-up string, there being usually four strings permissible. Packing paper and sometimes stiff "backs" are placed on the strings and the knots of yarn placed on the paper; sometimes, however, no paper is used until the bundle is removed.

It is possible to turn the machine by hand, as there is always a fly-wheel conveniently placed for the purpose. Modern presses are usually fitted for power driving, and, the belt being put upon the fast pulley, in Coleby's press the double purchase of very strong gearing is thereby rotated.

SUBSEQUENT TREATMENT OF THE SPUN YARN.

Q. 1898. What are the principal differences between lace and sewing threads? How is each prepared, and what differences exist in the appearance of each when in use?

A. There is only one way of producing the strongest and best cotton yarns, and that is by spinning single yarns carefully up to more or less fine yarns, and then doubling single threads together so as to produce a coarser thread of the requisite dimensions. Lace and sewing threads are alike in that in each case the finished article must be of superior quality. They differ in that lace cotton, when ready for use, is generally much finer than even the best sewing cottons, and beauty and appearance are perhaps more essential in the lace cotton, while strength is the essential requisite in sewing cotton. In both cases the yarn from the spinning machine may be passed through the doubling winding machine and the doubling twisting machine. While the spun yarn for the lace trade must invariably go through several operations at the spinning mill, the cotton for thread is very frequently sold in the cop to the thread makers, who themselves subject the yarn to all the operations deemed requisite for preparing the thread for the market. For the better kinds of sewing thread the spun yarn may be subjected to the following operations: (1) Doubling winding, (2) ring doubling and twisting, (3) re-winding, (4) finisher ring doubling frame, (5) glazing or polishing and winding upon suitable bobbins, (6) spooling or balling according to the market.

About 60's single yarn is very largely used in the production of sewing cotton, while from 100's up to 200's are probably more common for the lace trade.

For the lace trade the single yarn may be put through the doubling winding frame; then through the doubling frame, where the ends are twisted together, and the doubled threads wound upon bobbins. Sometimes the winding frame is dispensed with, and some lace yarn is doubled on the flyer throstle frame.

After doubling the threads may be cleared, gassed and picked. In some cases it may be passed through the preparing machine and sorted, and finally reeled and bundled ready for sending to the lace manufacturer.

The finished lace threads will be very much finer than the finished sewing threads, and of a more golden colour, and it would be difficult indeed to get mixed in them.

Q. 1897. Enumerate the processes necessary for the production of glace sewing threads, beginning with the single yarn.

A. The word "glace" being taken as the equivalent of the word "glazed," it may be said that for sewing thread it is very probable that the single yarn would be spun on the mule, although there are exceptions in favour of the ring.

The cops would probably be next taken to the doubling winding frame, which is a machine of somewhat recent adoption, in which from two to six threads can be doubled together and wound on bobbins or "cheeses" without twist being put in. Occasionally, even now, this machine is not used, and formerly it was usually omitted, and the cops or bobbins taken direct from the spinning machine to the doubling or twisting machine, with both doubling and twisting proceeding simultaneously.

The adoption of the doubling winding machine, however, enables "single" and "cork-screwed" yarn to be much more easily prevented by the means of a specially provided "detector wire" stop motion, which can be readily applied to such a machine, while it is difficult to satisfactorily apply it to a twisting machine. The threads having been doubled at this machine are at the same time formed into bobbins or cheeses, which are then taken to the twisting machine, this latter usually having its spindles revolving the contrary way to those in which the spindles of the spinning machine revolved. For sewing thread the cotton is often cabled by passing again through the winding and twisting machines. Afterwards the thread may be subjected to a polishing and glazing process, there being one or two principal methods in vogue. Then it may be wound into suitable shape, and finally spooled or balled for the market as required. It may be added that one method of polishing consists of forming a kind of warp or chain out of 360 bobbins. The chain is first bleached or dyed, and then passed through a special size mixture, after which the yarn is subjected to the action of rapidly revolving brushes before being spooled.

PREPARING.

The preparing machine is a strongly built machine, in which hanks of yarn are passed through large, heavily weighted calender rollers of compressed paper or other material.

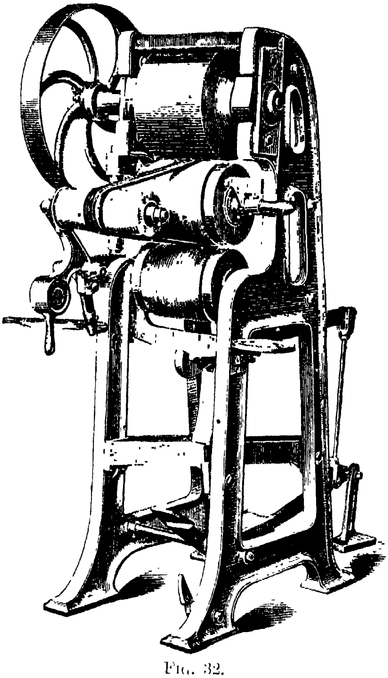

FIG. 32.

This process imparts a very high polish to the yarn, which is often heightened by the application of some kind of polishing substance. This process also flattens the thread, and makes it more suitable for winding upon the small wooden spools often used in the shuttles of sewing machines. A good idea of this machine will be obtained from Fig. 32, which shows a portion of yarn passing between the calender rollers.

Q. 1899. What differences exist in crotchet, sewing threads and double warps? In preparing them for the market, or use, what processes, if any, does each undergo after they are twisted? Give your answer in full.

A. After twist has been finally put in at the ring doubling machine, crotchet yarn is subjected to a somewhat different process of bleaching and colouring than sewing thread. It is also made up more frequently into balls, whilst sewing thread is wound on bobbins more often than otherwise. It is in the method of making up for the market that one of the chief differences between the two comes in, the balling machine used for the crotchet thread being very different from the spooling machine used for the sewing thread. Spooling is much more largely practised than balling, and is often done on a very ingenious machine invented by Mr. William Weild. The machines referred to are fully described in other answers.

Q. 1900. How many times, in your opinion, should yarn be twisted to produce six-fold thread? In what direction should the twist be introduced at each stage, and why? What are the number of turns per inch to be given to the thread at each stage, selecting any counts you like?

A. It is found to give by far the best thread—whether we consider the strength, softness or appearance of the thread—to give it a double twist. That is to say, instead of doubling all the six threads together at one operation, we first double the single threads together in two's and three's, and afterwards combine these so as to produce the requisite six-fold.

Take the case of six-fold sewing thread. It is good practice to put the standard turns of twist into the single thread —*i.e.*, square root of counts × 3·606, using Egyptian cotton, and taking, say, 80's twist. We may then double the 80's single yarn into two-folds, putting in from twenty to twenty-four turns of twist per inch, the same way as single twist, the multiplier being about 3¼. Then we may double and twist three of these two-folds together, putting the twist this time the *opposite* way to the former twistings, and putting in again from twenty to twenty-four turns per inch. This doubling together of three two-fold threads is often termed cabling. The yarn is therefore twisted three times over.

GASSING.

Q. 1896. Give a general description of the process of gassing. Say for what classes of yarns it is used, and why.

A. The great feature of the operation of gassing lies in the fact that each thread is drawn rapidly through a gas jet several times—say about seven usually. The burners used vary in construction, but are mostly of a Bunsen type, so arranged that there is a small amount of flame and a proportionately increased amount of heat. For this purpose a certain amount of air is allowed to pass into the burner along with the gas. The burner may be arranged transversely so as to gas each thread to a small degree six or seven times, or it may be arranged to gas each thread once only, but for a longer period than with the other method. The brass bowls round which the threads pass are made to revolve very easily, and are pulled round by the friction of the threads passing round them. The threads are pulled from a specially constructed creel, round guide rods, and after gassing are wound usually into small cheeses by frictional contact with revolving drums. There is a swivel arrangement by which the gas jet can be moved out of the path of the thread during the piecing of broken threads, etc. After gassing the threads appear to be much browner than previously, and gassing is performed in order to make the thread to imitate silk, and when it is going to be used for lace purposes. During the passage of the thread through the flame all the loose, oozy fibre is burnt from it, and this makes the yarn finer, and has to be allowed for in the counts of ungassed yarn. For instance, if 100's gassed yarn were required, we might have, say, 94's ungassed yarn. A steady flame and a uniform speed of the machine are necessary in order to give a uniform amount of gassing.

Handkerchiefs, neckties, ribbons, underwear, stockings, etc., made partially or altogether from good cotton yarns, gassed, and probably dyed, may pass very easily as silk goods with many people.

The brass bowls and other parts are apt to get sticky and

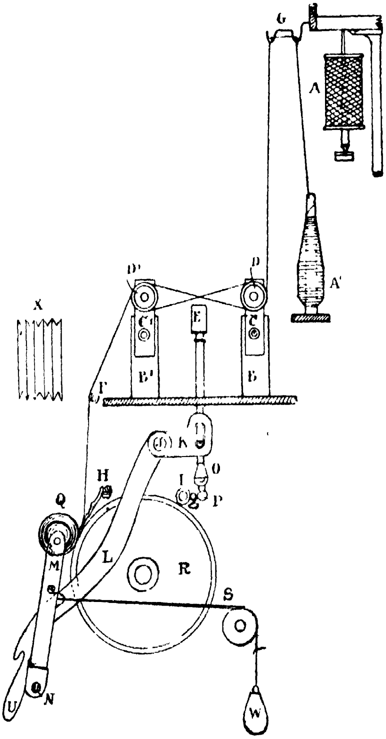

FIG. 32 (*a*).

dirty as the result of the burning of the yarn, and care should be exercised to ensure sufficient cleaning.

Referring to Fig. 32 (*a*), the yarn intended to be gassed is shown as being drawn from the ring frame bobbin at A′, but may be taken from winding frame bobbins disposed as at A. The ungassed yarn passes upwards and over the guide and tension wires at G, and then extends downwards and passes in a crossed fashion several times round the brass bowls, D and D′. A bowl is shown separately at X. The bowls rest loosely on pins carried by the adjustable brackets, C and C′, which latter are supported by the stands, B and B′. The gas issues from the burner at E, in such a manner as to meet the yarn at the crossing of the threads. After gassing the thread passes downwards over the guide rod at F, and upon the cheese at Q. The latter is rotated at something like a uniform surface speed by resting on the revolving drum, R. The weight, W, is suspended from a chain, S, which passes over the guide bowl, T, and is then attached to the cradle lever, M, which carries the cheese or bobbin, Q, of gassed yarn. In this way the frictional contact of Q with R is maintained.

For piecing-up and other purposes the attendant pulls at the handle, U, of the lever, L, fulcrumed at J. This has the effect of pulling the bobbin holder, M, forwards, and the bobbin, Q, away from contact with the revolving drum. N is the fulcrum of the bobbin lever, M. At the same time the burner, E, is swivelled on one side on its fulcrum at P, so that the gas is no longer acting on the yarn. After piecing-up the dropping of the lever, L, almost simultaneously permits the gas to come under the yarn, and the cheese, Q, to come in contact with the drum, R. The gas enters at I. In the burner shown air may enter at O.

A general view of the gassing frame as made by Dobson & Barlow is given in Fig. 32 (*b*).

The gassed yarn is wound on to wooden tubes, dispensing with the expensive cost of bobbins with heads. The bobbins made on this principle can be reeled off endways instead of having to be reeled from a revolving spindle, consequently bobbin-reeling is dispensed with or converted into the process of cop-reeling, which means that the speed of the reels can be probably doubled, and a considerable saving in the cost of reeling.

It is contended further than this that one reeler could mind two reels when reeling from the bobbins referred to—even at the increased speed of the reel—with as little labour as would be required to mind one reel when reeling from bobbins with heads on the ordinary principle, thus causing a still greater saving.

Upwards of six times as much yarn can be put on the

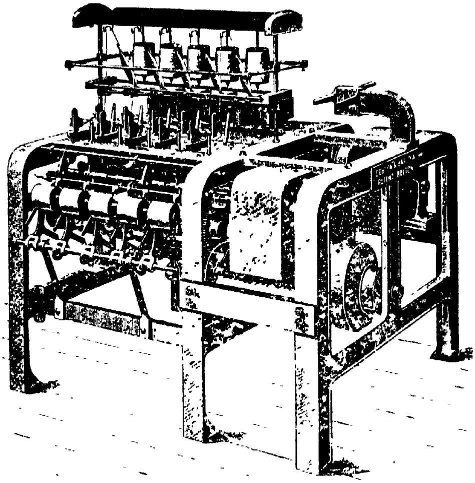

FIG. 32 (b).—Improved Gassing Frame, with patent quick traverse motion.

wooden tubes used on this frame as on the bobbins with heads used on some older kinds of frames. This, of course, means less piecing and doffing, less waste and attention, fewer knots and increased production, with only one-sixth the creeling in the reels.

CHAPTER V.

WARPING, TESTING, COMMERCE AND USES OF YARNS.

Q. Describe the process of warping.

A. It must be clearly understood that warping follows winding on such frames as the vertical spindle winding frames shown in Figs. 24, 25 and 26.

There are three principal methods of preparing weaver's warps, *viz.*, by the warping mill, the sectional warping machine, and the beam warping machine.

Such spinning mills as are accustomed to sell yarn in the shape of warps appear often to use the warping mill, and the description here will be confined to this machine, which is the oldest of the three systems.

The principal parts of the machine are the creel, the heck, the mill and the reversing motion.

The mill is really a gigantic reel mounted on a vertical axis and reaching from 15 to 20 yards in circumference. At the foot of the vertical shaft of the mill may be fitted a bevel wheel driven by another bevel on a low cross shaft. This shaft is operated from the headstock or pulley shaft, and in this way the mill may either be rotated by hand or by power, first in one direction and then the other, the gearing forming a reversing motion.

The creel is a vertical curved framework arranged to hold the bobbins in a horizontal position.

The heck is between the creel and the mill. It consists of a long box or frame containing a good number of polished steel eyelit pins, these being for each thread to pass through. Besides assisting to guide the threads properly upon the mill the heck greatly assists in forming the lease. The heck is in two parts, and by pulling at the proper handles the threads are divided into two sets, and either one set or the other can be thus placed in the lower or higher position. The lease thus formed is preserved by proper pegs and tieing-up.

By the "lease" is meant the alternate separation of the threads, in order to facilitate the finding of the threads in the succeeding processes. There may be upwards of 500 bobbins or more in the creel at one time if necessary.

The threads from the creel bobbins are passed through the heck-box, and then gathered together in a loose rope and attached, say, to the top of the mill. The latter is revolved so as to wind the rope of yarn round the mill, and the yarn is wound on in a spiral form by the descent of the heck at a definitely regulated speed.

When the yarn has been wound sufficiently low down on the mill the latter is reversed and a second layer of threads wound over or between the first one.

The process is repeated a sufficient number of times to give the required number of threads for the warp. Suppose there are 400 bobbins in the creel, and 1,600 threads are required in the warp, then 400 × 4 would mean 1,600 threads in the warp, obtained by four reversals of the reel. The length wound on the mill during one up or down motion will represent the length of the warp, and may be, for instance, 340 yards. This length will depend upon the circumference of the mill and the number of revolutions during the lift.

When finished the warp is wound off and formed into a large ball, and balling is one of the most important duties of the warper.

The terms "beer" and "porter," sometimes used in connection with warping, have been probably derived from the "porterage" or "bearing" of the yarn formerly necessary in very old systems of warping, the word "beer" in England being synonymous with the word "porter" in Scotland.

Q. In a warping mill for ball warps, how is the warp or yarn guided up and down the mill?

A. The yarn is *guided principally by the motion of the* heck-box, which receives its traverse from the central shaft of the mill by means of a suitable train of wheels and a rack and pinion arrangement.

The weight of the heck-box on the principle of a hoist is counteracted by a balance weight attached to it and hanging over a pulley. Naturally the reversal of the mill compels the reversal of the heck.

BALL WARPING.

It is remarkable how little the process of ball warping on the large warping mill has altered during the last seventy years. The accompanying Fig. 33 is taken from Dr. Ure, and his description is reproduced *verbatim*. Dr. Ure says:—

"The bobbins are mounted loosely on spindles on a frame, so that they may revolve and give off the yarn freely. The warper sits at A and turns round the reel, B, by the wheel, C, and rope, D. The yarn on the bobbins is seen at E. The slide, F, rises and falls by the coiling and uncoiling of the cord, G, on the shaft of the reel, H. By this simple contrivance the band of warp yarns is wound from top to bottom, spirally, round the reel. I, I, I, represent wooden pins similar to those used in peg warping. Most warping mills are of a prismatic form, and have twelve, eighteen or more sides. The reel is usually about six feet in diameter[1] and

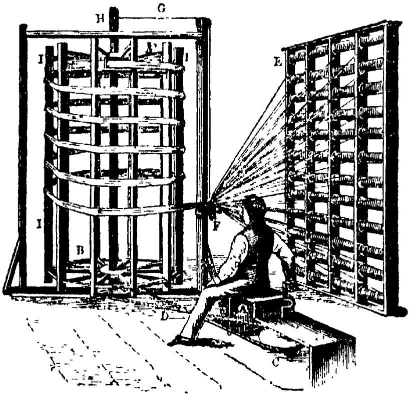

FIG. 33.

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[1] The warping mills in use now are much larger than this and usually fitted up for power driving.

seven feet high, and serves to measure accurately, on its circumference, the length of the warp. It may be turned either way by a rope moved by the trundle, C, which is actuated by the warper's hand.

"At E is the frame to contain the bobbins, the threads from which pass through the heck placed at F. This now consists of a number of finely polished and hard-tempered steel pins, with a small hole at the upper part of each to receive and guide one thread. The modern heck contains two parts, either of which may be lifted by a small handle below, and the eyes of each are alternately placed. Thus when one is raised a vacancy is formed between the threads, and when the other is raised the vacancy is reversed. By this the lease is formed at each end of the warp, and thus is preserved by appropriate pegs. These being carefully tied up give the rule for the weaver to insert his rods. The warping mill is turned each way successively until a sufficient number of threads are accumulated to form the breadth wanted. The warper's principal care is to tie immediately every thread as it breaks, otherwise deficiencies in the chain would exist, highly detrimental to the web, or productive of great inconvenience to the weaver. The box which contains the heck slides on an upright rod as shown in the figure."

VELVETS AND MERCERISING.

Q. If you had an exceptionally good order for 50's weft for velvets, what cotton and hank roving would you spin it from?

A. There are certain specially good grades of American Orleans cotton, such as Bender's and Peeler's or Mississippi bottom land cottons. These have long been in great favour for velvets on account of their lustre and silkiness, and it is very probable they would be used for the order under notice.

Brown Egyptian cotton is also in great demand for such goods as velvets, as it differs little in quality, price and effect produced from the Orleans cottons above specified, although there is a considerable difference in the colours of the two cottons. Ten-hank roving put up double would be very suitable in either case.

Q. 1900. A good deal of yarn is now being used for "mercerising". State (*a*) what kinds of cotton are best, (*b*) how they should be prepared and spun, (*c*) how they should be twisted. Reasons for your answers must be given.

A. The process of "mercerising" is said to have been originally invented about 1844 and patented about 1850 by John Mercer, a printer or chemist, of Blackburn. John Mercer's patent was for the purpose of subjecting vegetable fabrics and fibrous materials, such as flax or hemp, to the action of caustic soda or caustic potash, dilute sulphuric acid or chloride of zinc, of a strength and temperature sufficient to produce certain new effects. For various reasons, such as imperfect application and development of the process, cost of the process, shrinkage of materials subjected to the process and improvements in other directions, "mercerising" for very many years received little or no favour or adoption. Quite recently the subject has been taken up again very strongly, and various patents have been taken for improvements in "mercerising," and it would appear that it has now come to stay.

In the process of "mercerising" cotton yarns have imparted to them a durable lustre which makes them look like silk.

Probably the best cotton for "mercerising" is brown Egyptian, and the new process appears likely to increase the demand for brown Egyptian yarns.

The yarns are best combed and somewhat soft twisted and made into two-folds, as in this case the yarn takes the "mercerising" process most readily and perfectly.

At the present time (June, 1901) "mercerising" may cost about 6d. per lb. of 60's two-fold. The price per lb. of such yarn, bleached, dyed and "mercerised," from very good cotton, may reach 2s. 6d.

YARN TESTING.

Q. 1898. How would you test yarn for strength and elasticity? What precaution would you take to avoid error, and what particulars would you note? What classes of yarn require the greatest amount of strength or elasticity respectively?

A. The usual method of testing yarn for strength is to take a lea from each cop by means of the wrap reel, and to place this lea upon two hooks of a strength testing machine

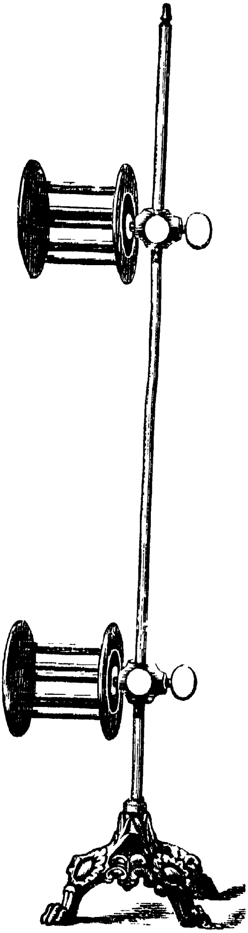


FIG. 33 (*a*).—Hank Stand.

specially constructed for the purpose. The machine contains an indicator face and finger, which show the amount of pressure exercised upon the yarn. The lea of yarn being placed on the two hooks, the lower hook is moved downwards by means of a suitable handle and worm arrangement. This puts the yarn under tension, and exercises a proportionate pull upon the upper hook, which pull is transferred to a spring and weight arrangement, so that the weight is moved upwards at the same time, causing the indicator finger to move round. The weight is prevented from falling backwards by a catch and concentric rack for the catch to fit into. Suppose the indicator finger pointed to 80 lb., then that would be the breaking strength of the yarn.

The same testing machine is often fitted with a small arrangement by which an idea of the elasticity of the yarn can be obtained. Connected to each hook may be a pointer referring to certain marks made upon the stem or tube of the testing machine.

Suppose in testing one lea of yarn for strength we also noted its amount of elasticity, and the lower hook moved downwards 3½ inches while the upper hook only moved 1 inch downwards, then the elasticity would be the difference between the two, or 3½ minus 1 equals 2½ inches of elasticity.

In many cases practical men depend more upon simply testing the yarn manually than upon the machine. A portion of thread is extended between the hands and delicately pulled until it breaks, by which time a fair idea will be conveyed to the mind of an expert as to the comparative amount of elasticity and strength possessed by the yarn. Single thread testing machines are in use in a few cases. As regards the precautions for avoiding error, perhaps the best is to check the results by making several tests and taking an average of them. In some cases the testing machine is revolved by power from a steady, slowly revolving shaft, and this practice undoubtedly tends to give more accurate results. In any case too much care cannot be exercised in making the tests properly in all respects.

As regards strength alone, it might be said that sewing thread most certainly requires strength, while warp yarn requires elasticity, and, for the matter of that, strength, though not as much of the latter property as sewing thread.

Fig. 34 is an illustration of this type of appliance, while

Fig. 33 (*a*) shows a hank stand which is sometimes useful for placing hanks of yarn upon.

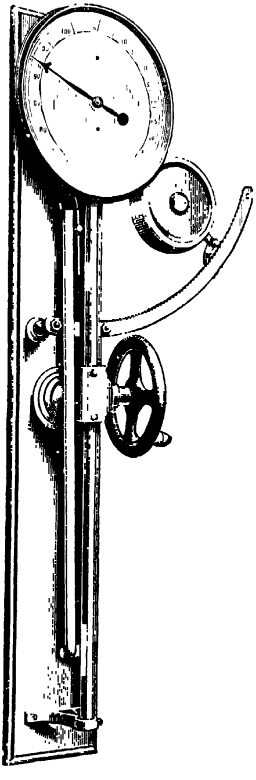


FIG. 34.—Tester for Strength and Elasticity.

It may be added that an apparatus can be obtained by which yarn can also be tested for moisture and twist, but these are not as yet very extensively used by cotton spinners. Small blackboards or inspection cards are often used, in which yarn is wrapped on a black surface, so as to show up dirt, leaf, nep and unevenness.

The most common test of all is, of course, that for counts.

Q. In order to test the counts of cotton it is usual to divide the number 1,000 by the weight of 120 yards in grains. What is the reason of this? How has the number 1,000 been arrived at for this purpose?

A. Fig. 35 is an illustration of a type of yarn wrap reel in common use. It has to be remembered that in cotton spinning 840 yards = 1 hank, and the number of hanks contained in 1 lb., or 7,000 grains, equals the counts. If we divide 7,000 grains by the grains in a hank the quotient will be the counts, therefore, if we take $\frac{1}{7}$ of 7,000 grains and $\frac{1}{7}$ of a hank, it gives just the same result. That is to say, taking 1,000 grains for the dividend, and a lea of 120 yards as the divisor, will give exactly the same quotient as with 7,000 as the dividend and a hank of 840 yards as the divisor.

This may be illustrated by counts 1's. Suppose a hank to weigh 1 lb., or 7,000 grains, then $\frac{1}{7}$ of the hank, which is a lea of a 120 yards, would weigh $\frac{1}{7}$ of 7,000 grains, that is to say, 1,000 grains.

$$\frac{7{,}000}{7{,}000} = \frac{1{,}000}{1{,}000} = 1\text{'s.}$$

A general rule which can be used for finding the counts, alike for the lap from the blowing-room or the sliver lap machine, the sliver from the card, comber or drawframe, the roving from any of the bobbin and fly frames, or the yarn from the mule or ring frame, is as follows:—

Take for a dividend the constant $8\cdot\dot{3}$, multiply the number of yards of cotton wrapped, and for a divisor the weight of the cotton reduced to grains. For the case specified in this question this would give—

$$\frac{8\cdot\dot{3} \times 120}{\text{weight of 120 yards.}} = \frac{1{,}000}{\text{weight of 120 yards.}}$$

The constant $8\cdot\dot{3}$ is simply obtained by cancelling 7,000 by 840.

Fig. 35 illustrates the kind of wrap reel used for testing the counts of the spun yarn.

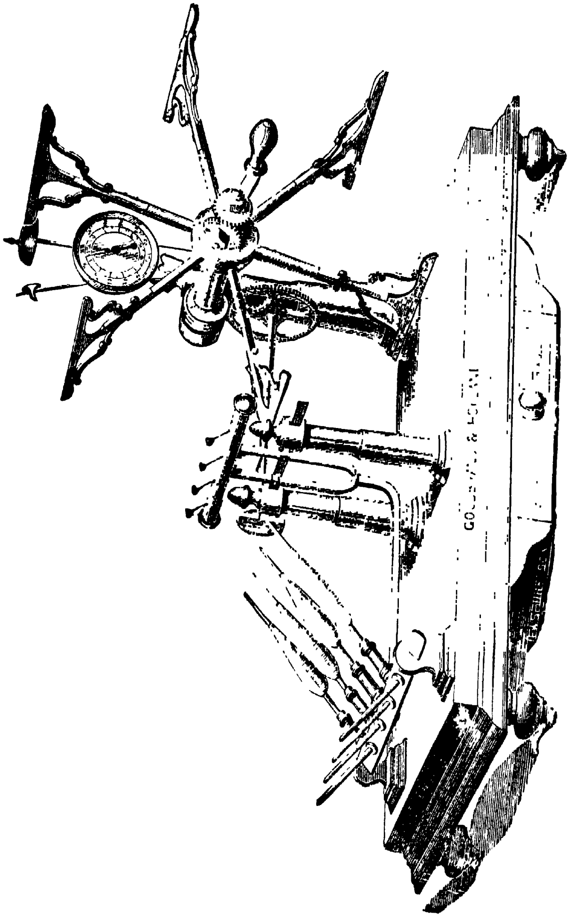


FIG. 35.—Wrap Reel for Yarn.

KNOWLES' YARN BALANCE.

This is shown in Fig. 35 (*a*), and is an exceedingly sensitive and accurate machine for testing the counts of yarn, and has found a good deal of acceptance at the hands of spinners, doublers and manufacturers. It does away with dwts. and grains and printed yarn tables.

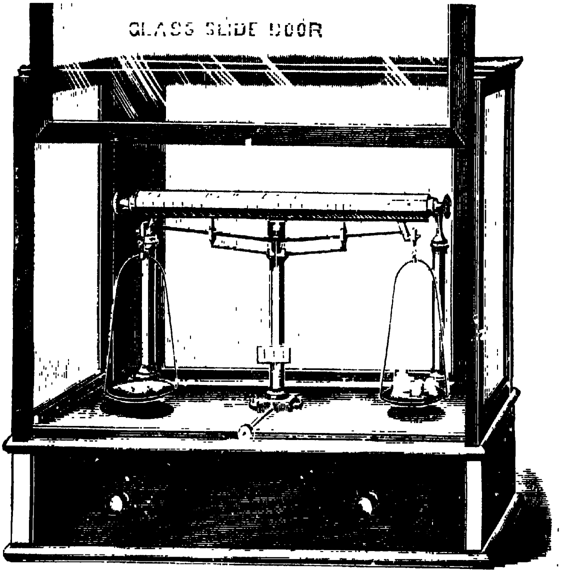


FIG 35 (*a*).—Knowles' Yarn Balance.

The counts are indicated on the engraved bar, the apparatus being constructed to suit any special range of counts required, either cotton, worsted, linen or other yarns, and for one or more leas.

There is a lever for lifting the scale pans from the box. Behind the beam there is a bar engraved and silvered with six or eight flats as may be required. Each flat is marked with a letter, A, B, C, etc., according to the number of flats, and a corresponding weight, A, B, C, etc., which is placed on the pan. There is also a slide or indicator for each flat, lettered A, B, C, etc., to correspond. The indicator slides upon the beam.

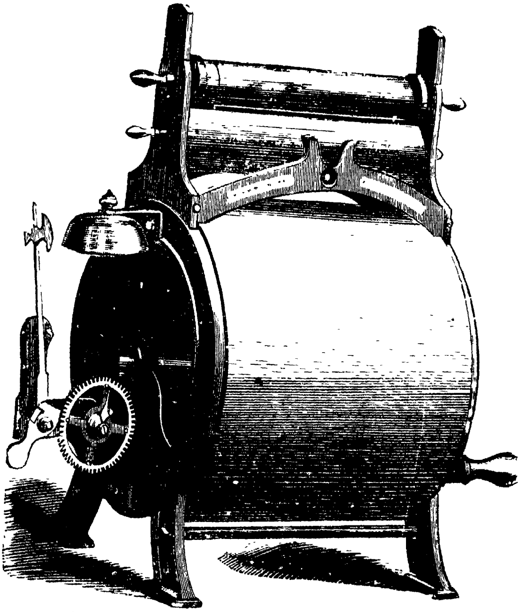


FIG. 35 (*b*).—Wrap Reel for Slivers and Rovings.

To Test Counts of Sliver and Roving.—In order to prove or test the counts of the cotton from the drawframes and bobbin and fly frames, it is customary to use a wrap reel, such as shown in Fig. 35 (*b*).

To test the counts of sliver it is usual to take from three to six yards, the length varying with different people. The wrap block or reel is one yard in circumference, so that six revolutions of the handle would give six yards, supposing such a length was required. In practice the person making the test knows exactly what should be the weight for his certain counts. If various weights are used, it may be convenient to have a table of weights and counts, and such a table is easy to make.

In the case of roving testing the same apparatus is used, and possibly sixty yards taken, *i.e.*, sixty revolutions of the handle. The bell may ring at every fifteen or thirty yards or so, as may be required.

Q. 1901. Is it possible to ascertain the twist in single yarns by any machine? If not, how would you most accurately ascertain it? What effect has twist upon the elasticity of yarn? In yarn intended for the pile threads of velveteens is strength or elasticity more important?

A. There is a simple machine in extensive and successful use for testing the twist of double threads, and the same machine has been often tried for testing the twist of single yarns. The experience of the author is not in favour of this apparatus for testing the twist of single yarns, and he is not aware of any other apparatus that is really satisfactory and fit for practical mill use in this connection. The machine referred to consists of two pairs of brass nippers or jaws, between which any length of yarn from 1 inch to 12 inches can be extended. One of the jaws is fixed while the other is rotated to take out the twist, and the difficulty with single yarns is to tell when the twist is taken out, on account of the yarn going soft and slack. It is contended by some that by using the microscope or a good magnifying glass, and taking only a short length of yarn, a sufficiently accurate idea of the twist per inch of single yarns can be got by this apparatus. In the spinning mill itself the twist is ascertained from the wheels on the spinning machines, or else by an indicator placed on a spindle. An approximate idea of the twist in yarns is often obtained by pulling a short length off a cop, letting it hang down, and noting the amount and quickness of the twisting or curling up of the yarn. Up to a certain point twist may be said to impart elasticity. For instance, roving is so softly twisted that it will at once draw out and not have the ability to return or shrink up again. By the insertion of sufficient twist into this soft inelastic stuff it is made to possess the property of elasticity.

On the other hand, yarn usually has sufficient twist to give it some elasticity, and in most cases of ordinary yarn if additional twist is inserted it will probably detract from the elasticity while adding to the strength. The elasticity of a yarn is expressed by the increase in length it undergoes when strained to breaking point. As few spinning students know much about velveteen cloth, a few words are given descriptive thereof. When dyed and finished this cloth has a soft and lustrous appearance, and in addition is capable of withstanding a good deal of wear and tear. Its excellent properties are mainly due to the method of construction and the quality of material put into it. In order to produce its special effect certain floats of weft are cut on the upper side of the cloth, the cut threads then rise and close up together. Oldham district is noted for this kind of work. For good velveteens the warp is very often made from Egyptian cotton of good quality very well spun. As it is a weft pile it is scarcely necessary that for the pile yarn a great deal of strength should be required, while the feel of pile may be aided by the elasticity of the yarn, so that it would be inferred that elasticity is the more important in this case, although weavers themselves differ on the point, and say neither of the two is more important than the other. The real essentials of this pile yarn are that it should be soft, silky and spun from really good American cotton, or possibly Egyptian.

THE COMMERCE AND USES OF YARNS.

Q. What are yarn agents, and what are the duties they ought to properly perform for spinners? State the terms on which yarns are usually sold to the home trade and to the shipping or export trade.

A. (1) *Agents.*—Yarn agents are persons who make it their business to sell the yarn produced by spinning mills. They may arrange for transactions between spinners and weavers or the sellers and buyers of yarn.

In some cases agents act specifically for certain firms. In many cases agents act for various spinning firms, and the same spinning firm may sell yarn through different agents.

some such cause as bad rollers or irregular rovings. A very large number of circumstances may cause snarls, and we only indicate here the method of procedure in finding out the cause in any special case, the best thing possible being, of course, for a good practical overlooker to examine the mules themselves.

As regards thick places, their character would very soon enable a practical man to somewhat localise the possible causes. Taking first "thick" roving, this, of course, is mainly caused by the carelessness of the bobbin and fly-frame tenters, as are bad piecings of the rovings, which can be easily localised by their short, hard, twisted and thick character, this being, indeed, so strongly marked that they almost invariably break the threads down.

If the thick places were short, raw portions we should immediately look for the cause in dirty rollers and clearers and back-roving guides, or noting them to be present in the bobbins the matter would be relegated to the carder, who would probably find it due to dirty flyers on the fly frames, or to dirty and poor clearers on the drawing frames.

Again, if the thick places were accompanied closely by thin places, we should soon be examining the rollers of the spinning machine as regards the roller gearing, while, if the thick places were present at more intermittent stages, it would be well to find out whether short and long cottons were being mixed together. Bad piecings at the spinning machine could easily be recognised. Thick places are often caused by over-running of the mule creel-bobbins.

Q. 1897. What classes and counts of yarn are used for making lace, hosiery, sewing thread and print cloths? State the properties which make them respectively suitable.

A. Cotton yarn for the manufacture of lace is largely cleared and gassed. The clearing apparatus is simply a winding frame, which has for its chief purpose the passing of the thread through small adjustable apertures which will not allow any leaf, dirt, etc., to go forward. In gassing the thread is drawn rapidly through a gas jet, which burns off all the loose fibre, a burner of the Bunsen type being preferably used. The process also browns the yarn. The counts spun for lace purposes are largely medium fine from Egyptian cotton, this being mostly sent Nottingham way.

Hosiery yarn is of a very different stamp to lace yarn. It is usually soft twisted, the common multiple for twist per inch being square root of counts × 2·75. For the lower counts, say from about 4's to about 20's or so, a mixing containing about four-fifths of Tinnevelly cotton, assisted by a little American to strengthen it, is often used. For the finer counts, say up to about 36's, a much larger proportion of American or Brazilian cotton may be used. A good deal of this yarn is used up in Nottingham, Leicester, Bolton and in Yorkshire.

Sewing threads require the best yarns made, Egyptian and Sea Islands cotton being largely used for the purpose. Sewing thread must invariably be of great strength, and this can only be obtained by spinning fine yarns from good cotton and afterwards doubling two or more of the single threads together. For instance, for 12's sewing thread we might have say 50's to four-fold, etc.

Print cloths absorb much more of the American cotton than any other sort. Taking chiefly anything from 20's to 60's, the yarn is used up in the weaving mill for the manufacture of cloth, without anything being done to it after spinning excepting damping and adopting satisfactory means of transit. It is used in the grey without either dyeing, bleaching, doubling, gassing, reeling or any such process, and afterwards the cloth is submitted to whatever processes are necessary to give the required pattern and finish.

Q. 1899. Why is yarn conditioned? How much added moisture is permissive? Say how you would ascertain the amount, and whether weft or twist requires more. State what you know about the various methods of conditioning. Say which you prefer, and give full reasons for your answer.

A. It is probable that conditioning of yarn originated, and depends primarily for its existence, in the fact that after damping the yarn is often found to wind and weave much better than when warm from the spindles or the spinning machine. At the present time many combined spinning and weaving concerns, although using their own yarn, regularly use the damping cellar or other conditioning apparatus for no other reason than to get the yarn to work better in the weaving department. It has become the very general practice to damp the yarn in spinning mills proper, in order to add to the weight of the yarn, as compared to when it comes warm from the spindles. It is often the case that 5 per cent. is added in this manner, and so long as both spinner and weaver, or buyer and seller, are well aware of the conditioning the procedure is quite legitimate. In such cases it is considered in the price, and the buyer gets the benefit of having yarn that is made more workable.

Various methods of ascertaining the amount of moisture in yarn are more or less in vogue. One method is to place a given weight of yarn in a very hot room for a certain time, and to compare the weight before and after such exposure. A method recently come into prominence is to use a special oven, in which a few cops are placed for perhaps ninety minutes and heated to chemical dryness. Experiments have demonstrated that yarn should lose a certain percentage under such conditions, and in this way the results of any particular test may be compared to a standard. Recently the use of such ovens by manufacturers has led to considerable friction between them and the spinners who have served them. There are many manufacturers who take pains to damp their weft, but do not think it at all necessary to damp their warp yarn. One method of conditioning has been to expose the yarn in open skips in a cellar whose floor is kept covered by water. Sometimes the cellar is fitted with humidifying apparatus. In more hurried cases the degging can is used, or the cops are placed between damp cloths. It is a matter of opinion and special practice as to which is the best system of conditioning. (See also page 156.)

Q. 1899. Cloth is required to have a good cover or to be bare, to be lightly or heavily sized. What kind and counts of yarn would you use in each case, selecting any cloth you like to illustrate? If you want heavy sizing, would you use ring yarn or not, and why?

A. It is pretty generally considered that mule yarn will give a better cover to cloth than ring yarn, and especially with regard to the weft. In some cases it is found that a better cover is put on the cloth by using weft yarn twisted to the left or "weft" way, while the warp is twisted to the right or twist way. To get a good cover on the cloth it is advisable not to overtwist the weft. It is also considered that a loose, oozy mule yarn is the best possible for taking up a great percentage of size, although many people get all they want out of a ring-spun yarn. For a certain kind of printers it is found that about 30's warp and 38's weft give excellent results with light sizing, mule yarn and weft yarns twisted contrary way to warp yarn. It is possible to vary the cover on the cloth by adjustments at the loom.

Q. 1900. If in examining yarn you discover soft places at intervals, to what would you attribute and how remedy them? An ample answer is required.

A. The mixing together of long and short fibres of cotton is a cause of soft places in the yarn, or the presence of a large quantity of short fibres will cause it. If the traverse or guide tins or bars, or the top and bottom drawing rollers at any of the machines or the clearers, are allowed to get too dirty, often pieces of the fly will pass in with the rovings, and cause thick, soft places in the yarn. "Wafting" of the tins and creels often causes the same defect. Neglect to clean the flyers on the fly frames, or careless sweeping and cleaning of such parts, often causes thick, soft places in the yarn. Bad condition of the drawing rollers, or ineffectual weighting or neglect of oiling and cleaning, or wrong setting of the rollers, either at the final process of spinning or at the previous machines, are all causes of soft places in the yarn. Overrunning of the creel bobbins is sometimes a fruitful cause Hard-twisted and long piecings of the bobbin when creeling will cause the evil. "Thick" and "single" are special defects, which differ from the foregoing in showing up in larger portions. When making changes in the draft wheels and after "sawnies," it is often difficult to keep out defective places in the yarn. In the case of many of the foregoing evils it is at times exceedingly difficult for even good practical men to locate the exact cause of the defect.

Q. 1896. What is the purpose of conditioning yarn? Give briefly particulars of any system with which you are acquainted, and say how long the yarn takes to condition. What percentage of moisture is the greatest which ought to be added?

A. The object of conditioning yarn is in the first instance to add to it a certain amount of moisture, in order to impart additional elasticity to the yarn and to prevent it from breaking as often. It also has the effect of making the yarn more solid so as to tend to take out snarls and curling. Sometimes the weavers will absolutely pour water upon their cops out of their breakfast cans in order to obtain the above good effects. The worst of this and similar methods practised by weavers is that sometimes the yarn discolours the cloth. Occasionally weavers will put a damp cloth on their warp when it has been over-sized in order to soften it. A more important object of conditioning yarn from a spinner's point of view is to make it weigh heavier. With this object in view conditioning is carried out to such a degree that some managers regard the damping cellar as being one of the most important departments of the mill. A typical damping cellar should be shielded absolutely from the sun's rays, and it is all the better for damping purposes if daylight is almost excluded, although the basements of modern mills do not altogether possess these qualifications. The floor should be of concrete or other substance so as to be impervious to water. Layers of bricks are placed all along the floor, sufficiently apart to allow the skips of cops to rest firmly on the bricks. The skips should be very open, so as to give full opportunity for the moisture getting to the cops. Tins for holding the cops are unsuitable for conditioning purposes. The floor is covered with water to the extent of about two inches or so, but not sufficiently deep to touch the bottoms of the skips, as the cops would thus get much discoloured. Water pipes and taps are placed at intervals in the room, and the floor should be of a slight incline, so as to allow the water to drain off. The person in charge of the cellar should be careful to have a proper system and arrangement of putting the skips of cops into the cellar and taking them out again in proper rotation, so as to allow them all to have the same amount of conditionng as far as practicable. A week might be taken as a fair average time for cops to be under the conditioning process. Sometimes the author has known cops to be forgotten in the cellar until they had gone quite mildewed and rotten. Four or five per centage of moisture to impart by the conditioning process. The cops should be weighed upon entering and also upon eaving the cellar. Sometimes water is poured upon the cops rom a degging can, but this is always a dangerous process on account of the chance of discolouring the yarn. To give some idea what the spinner benefits by conditioning yarn, we will take a case of 60,000 spindle mill, with a production of 1 lb. per spindle per week, and an average damping of 5 per cent., and the yarn to sell at 6d. per lb.:—

100 : 60,000 : : 5 : 3,000.

3,000 lb. of water are sold as yarn at 6d. per lb.

2)3000

20)1500

£75

£75 per week of income from the conditioning process. In some cases a greater amount of water than 5 per cent. has been added to the yarn, so that this department may be well regarded as being one of the most important in the mill. (See also answer, page 151.)

It may be added that the ovens sometimes used for testing the moisture of yarns, are much similar to the one shown, Fig. 1, page 10, of this volume, as used for testing the moisture of raw cotton.

CHAPTER VI.

PRODUCTION AND COSTS, ROLLER COVERING.

Q. A mill produces 2,500 lb. of 30's, 3,000 lb. of 36's, 5,000 lb. of 40's, 8,000 lb. of 50's, 2,000 lb. of 60's. What will be the average counts?

A. The rule is to find all the hanks and all the pounds produced. Then hanks divided by pounds always give counts.

Lb.		Counts.		Hanks.
2,500	×	30's	=	75,000
3,000	×	36's	=	108,000
5,000	×	40's		200,000
8,000	×	50's	=	100,000
2,000	×	60's	=	120,000
20,500				903,000

903,000 ÷ 20,500 = 41 average counts.

Q. 1897. What is the basis of the wages paid for mule spinning in the Oldham or Bolton districts? Say which district you select, and give an example of the method of calculation adopted.

A. The list taken in this answer is Oldham.

Probably one of the worst points about the spinners' lists in some districts is that they permit very great and most unfair variations in the wages paid to different minders working under the same list, in the same town, and in some cases even at the same firm.

The author, when himself an operative spinner, had personal experience of such unsatisfactory conditions, and has often come into personal contact with extreme cases. In some instances minders have been working on old, worn-out, strained and broken down mules, with inferior cotton, and it has been quite impracticable for a capable minder, with really hard working, to earn more than 26s. per week average for himself

At the same time and in the same town other minders have been earning for themselves 50s. per week average, with no more anxiety or work, owing to having good, well-conditioned mules and good cotton, while at the same time receiving the same amount of money for the same amount of yarn turned off

While variations in wages earned must always exist to some extent, it is a grand thing about the Oldham list that they cannot reach very extreme limits, because an employer is bound to compensate a spinner for working on poor machinery with inferior cotton, while, on the other hand, the operative has to share extra wages earned by good cotton and machinery with the employer.

The Oldham list is a speed list, and it is specified that for mules of 63-inch stretch, of any size and counts, running three draws in 50 seconds, a certain price per 1,000 hanks shall be paid, and allowances are then made for any variable conditions. It may be said that the basis of the Oldham list consists in arranging the rules and conditions so that the minders' and piecers' wages shall be within certain limits no matter what kind of machinery, cotton or counts be in vogue.

This is true more particularly as regards the minder of average ability. At the same time it must not be forgotten that it is a piecework list, so that an idolent or unskillful minder may come below the average, while an industrious and skillful minder may earn more than the average. Also, the minder on long mules receives more than the one on short mules.

A brief answer to the question might be as follows: In proportion to the size of mule the total wages on the ticket should reach a certain pre-arranged amount, and according to the counts, spinning and size and speed of the mule the total hanks turned off by a mule should approximate to a certain total.

Then a proportion is established as follows: If the total wages for such a total number of hanks be such an amount, what would be the price per 1,000?

Example: It is estimated that a pair of mules are capable of producing 60,000 hanks of a certain yarn under fair average conditions, and it has been agreed on that the total wages of such mules for these hanks should be, say, £3 10s., what will be the price per 1,000 hanks?

60,000 : 1000 : : 840 : ?
= 60 : 1 : : 840 : 14d answer.

It is stipulated that the piecers shall receive a certain percentage of this amount. If a minder only produces, say, 56,000 hanks, then he will receive 4 × 14 pence less wages than the above estimated average, while, if he can produce more than 60,000 hanks, he receives so much more wages.

Q. 1901. State in detail the labour charges for preparing and spinning either 32's, 60's or 100's twist.

A. Taking a complete ring spinning and weaving establishment for the lower counts, a recent American writer gives the following table, from which an approximate idea of what the question requires can be obtained:—

	Per cent.
Overseeing at	15·87
Picking	1·45
Carding	4·46
Drawing	2·68
Roving and spinning	18·52
Ring cleaners	0·58
Back boys	1·65
Doffers	2·45
Spooling	3·86
Warping	1·18
Web drawing	1·51
Slashing	0·83
Weaving	44·96
	100·00

By comparing the foregoing figures a good idea of the expense of any one department as compared with any other can readily be obtained.

Q. 1899. Assume that you are spinning 32's yarn from a good sample of American cotton, costing 3½d. per lb., what would be its ultimate cost in the warehouse, including allowances for waste, labour, establishment charges and insurance? You may select either ring or mule yarn, but state which.

A. In a certain case which came under the present writer's notice of similar counts spun, part being frame and part mule, the total cost per lb. of the yarn was 2·04 pence. Providing therefore that the cotton cost 3½d. per lb. delivered at the mill, the cost per lb. of yarn to the master spinner in his warehouse would be 5·54 pence.

For some time now the cost of production has been rather more than it was when the foregoing particulars were taken, owing to the prices of coal and the rates of wages having increased. At the time of writing this answer, cotton is also much dearer than as above given.

It may be taken that a good modern mill, spinning 32's twist American cotton, can produce a pound of yarn at approximately 2½d., with average circumstances, and without allowing for any profit.

There is comparatively little difference in England between the cost of production of the yarn, whether spun on the mule or ring frame.

Q. 1898. What is the total labour cost (other than salaries) of 40's weft per 1,000 hanks?

A. The total amount paid in wages would probably approximate to something like twenty-two pence per 1,000 hanks, of which the spinner and his piecers would require something like 13·5 pence. This would leave about 8·5 pence per 1,000 hanks for the wages in the card and scutching rooms, and for overlooker's wages, the fly frames taking the major portion of this 8·5 pence. All this, of course, is quite exclusive of what the yarn costs in the way of coal, depreciation and various expenses, which, all combined, would not be a great way from approximating to the total cost of the labour. It must be remembered that the data given can only be approximately correct, since quite a number of circumstances tend to give a variation in actual practice.

INDICATOR.

One of the most popular forms of indicator as used on fly frames and ring frames for registering the hanks of cotton passed through the front roller to each spindle is shown in Fig. 36, and is made by Messrs. Orme, of Oldham. A is a worm on the front roller, and gives motion to the worm wheel, B.

The rotation of wheel B compels the forward movement of the dial numbers on the right hand. A complete revolution of these figures from 1 to 0 or 10 is followed by a forward movement of one number on the next dial, etc. The dials show hanks and decimal parts exactly as they are put down on paper. Thus the middle line, as shown, reads 42·2 hanks.

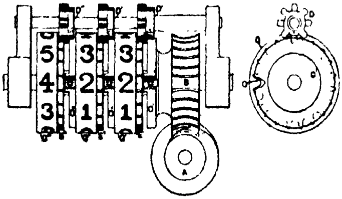


FIG. 36.

ROLLER COVERING.

Q. 1897. What are the chief defects which arise in leather-covered rollers during work? How are they prevented? What difference (if any) would you make in the leather or cloth used if you were drawing rovings for 100's or 24's yarn respectively?

A. It might be said that the chief defects are fluting, channelling, roughening, piecings giving way.

As is well known, flutes are hollow places made lengthways in the leathers, while channels are hollow places made circumferentially. Poor leather or inefficient covering will result in any of the above defects being developed. Neglect of cleaning and oiling on the operative's part, or inferior oil, would do the same. Channels are mostly caused by something being wrong with the roving traverse or tin guides placed behind the rollers, although hard piecings in the rovings, or the latter being hard twisted or rollers set too close, might cause the same evil. The piecings might give way through the use of poor cement or glue, or from want of a good press, or being put on too tight. The leather for rovings for 100's ought to be the best quality of Persian leather, this being very commonly employed, being smooth, thin and pliable, although firm.

For rovings for 24's we should have a cheaper quality of skin, which may not have had the same amount of care or labour bestowed upon its preparation. Welsh brown skins are commonly employed for such numbers. Sheep skins are generally used, although at times, especially for hard twisted yarn, other material has been tried.

It is well known that the leather should be made to have a cushion effect by a specially manufactured flannel being first applied to the roller.

Often for fine counts on the mule the flannel cushion is dispensed with.

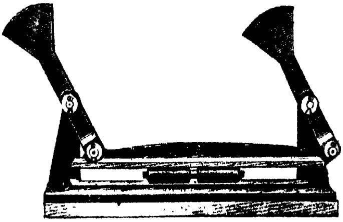


FIG. 37

Roller Tester.

The apparatus shown in Fig. 37 is made by Dronsfield Bros. for the purpose of testing or gauging the bosses of rollers to ascertain whether they are covered truly or otherwise. It consists of two parallel surfaces, the upper one being suspended to rise and fall to any diameter of rollers. By the use of this tester any irregularity in the covering of the rollers can be readily detected.

Q. How is the slubbing, roving and yarn injured when the top rollers are badly covered, or the coverings channelled by wear, and when the flutings of the bottom rollers are worn?

A. Uneven work is produced on any of the machines by channelled and fluted leather rollers because the channels and flutes detrimentally affect the circumference of the rollers and their biting and drawing power. On all the machines the cotton tends to stick to the fluted leathers, thus excessively breaking the rovings and threads, and leading to roller laps. Particles of cotton and dirt adhere to and accumulate on the rollers, and then pass forward with the cotton.

When the flutes of the iron rollers are badly worn they cannot grip the leathers of the top rollers nor the cotton fibres with sufficient certainty and power, and this leads to irregular drawing of the cotton, giving slack and tight rovings and threads, with inferior spinning and yarn Sometimes a steel rule laid on the rollers will show inequalities, or recourse may be had to the apparatus shown in Fig. 37.

Q. Describe the operation of covering the top rollers of mules and frames.

A. (1) The first thing is to get the flannel cushion for the leather cemented upon the bare iron. The operation of cutting up the flannel into long "strips" and into "squares" is often performed by hand, but machines are available by which this cloth is cut up, pasted and measured ready for application to the roller. The flannels are put end to end, with a "jump" piecing, while bevelled edges are made for the leathers, and are overlaid in piecing.

(2) By the aid of a suitable knife and a "cutting up" board the leather skins are cut up into long strips and then into "squares".

(3) The "squares" are shaped into "cots," and the cemented piecings rendered more secure by the aid of a press.

(4) A splicing machine is sometimes used before the previous process, and renders great aid in cutting the bevelled edges on the leather "squares".

(5) The leathers are drawn upon the bosses of the rollers by the aid of a "pulling-on" machine (shown in Fig. 38). Many of these machines stand vertically.

(6) The next operation is "ending" the leathers, by rapidly rotating the rollers in an "ending machine," and burning off the portions of leather projecting over the ends of the iron bosses of the rollers. Fig. 38 (*a*) shows one make of ending engine.

(7) It is now often the practice to place the leather-covered rollers into a calendering machine, in which the

rollers are rolled under pressure over heated surface plates, so as to put a good finish on them.

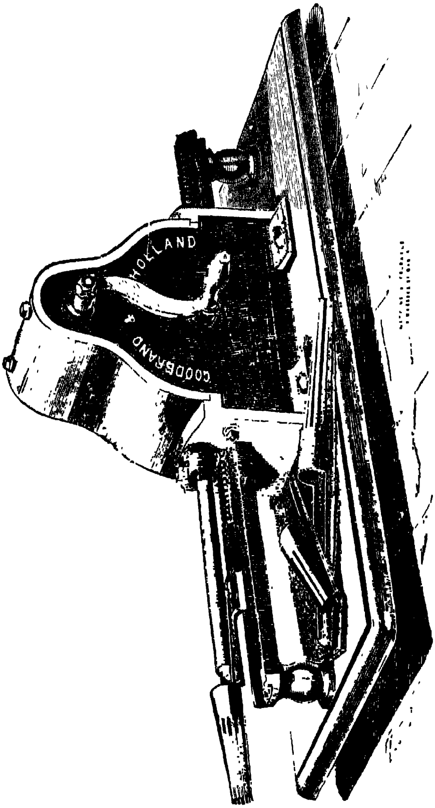


FIG. 38.—Horizontal "Pulling-on" Machine.

(8) In some cases a roller "tester" is employed, such as previously described.

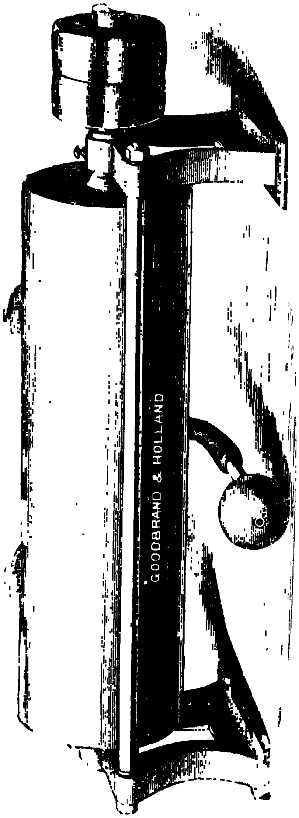


Fig. 38 (*a*).—Roller Ending Machine.

CHAPTER VII.

MAIN DRIVING.

Lighting, Humidifying and Fire Prevention.

Q. Briefly compare the various methods of main driving for cotton mills.

A. There are four methods of main driving more or less in use for cotton mills, *viz.*, by wheel gearing, belts, electricity and ropes.

(*a*) Wheel gearing is the oldest method, and, until recent years, by far the most extensively adopted. It is now very seldom applied. It is very noisy, very dirty and very subject to serious breakdowns and stoppages.

In this system there is usually a large spur segment wheel on the crank shaft, driving a smaller wheel on the second motion shaft. This shaft drives by bevel wheels the upright shaft, and from the latter the line shafts of the various rooms are driven by bevel wheels. There is no loss by slippage with this system.

(*b*) In England main driving by belts has only been adopted in a few cotton mills, and most of these have discarded it again in favour of ropes.

They are very liable to slippage, and sometimes have given unsteady driving and sometimes the breakage of a single wide belt has involved the stoppage of a large mill for a few days.

The cost of good belting appears also to be considerably more than that of the amount of good roping required to do the same work.

(*c*) In England the system of driving cotton mills by electricity does not appear as yet to have received any adoption to speak of. On the continent, however, it would appear that a fair number of mills have adopted this system, and it is by some considered as likely to receive extended adoption in the future.

Practically all the machinery at the Paris Exhibition was driven through the medium of electricity.

The electricity is generated at a central station, and there are two methods of distributing it to the machinery, *viz.*, by transmitting it to motors attached to the line shafts and then driving by the usual belts or ropes, or else by attaching the motors directly to the machines themselves. At the Paris Exhibition Messrs. Platt and Messrs. Brooks & Doxey adopted the former method, while the continental makers of cotton machinery appeared to prefer the more direct method. So far as the author could judge by carefully watching the machines both methods appeared to be satisfactory, but the direct method affords the great advantage of dispensing with the clumsy. troublesome and unsightly driving belts all over the mill. At present the great cost of the electrical method appears to be a principal objection to its use, although there are undoubted advantages in it.

(*d*) Rope driving at the present time is by far the most largely employed method of any for the main driving of cotton mills in England.

It has been commonly stated that a mile a minute was the extreme limit of effective speed for ropes, but Messrs. Kenyon, of Dukinfield, quote a case of 7,040 feet per minute at a Lancashire cotton mill working satisfactorily, special and extra attention being given to the construction of the fly-wheel to prevent collapse. With rope driving there is hardly any loss by breakdowns, as a faulty rope can be dispensed with for a time.

It is considered that good ropes for main driving ought to last from twelve to fifteen years under average conditions.

Generally the trailing span of the rope should be at the top in order to bite more of the pulleys.

The ropes should not exceed $1\frac{3}{4}$ inch diameter.

Curved sides to the pulleys encourage rolling of the ropes, and the rolling action diminishes their durability and driving power.

Rope driving is far quieter than wheels.

ROPE DRIVING.

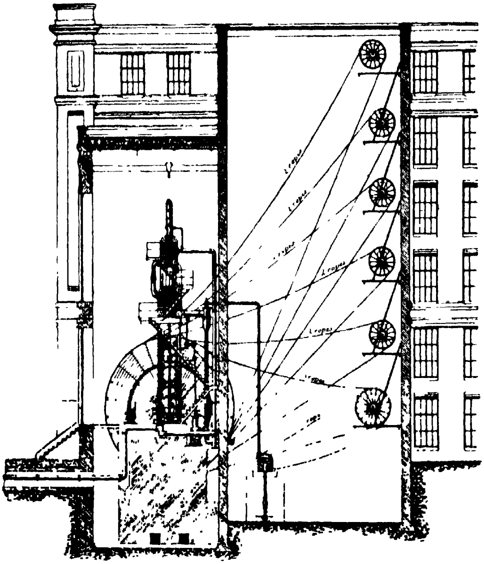


Fig. 39.

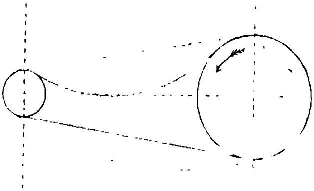


Fig. 40.

Figs. 39, 40, 41 and 42 illustrate various features belonging to rope driving.

Fig. 39 is a general view of the connection of the ropes from the large fly-wheel to the various rooms.

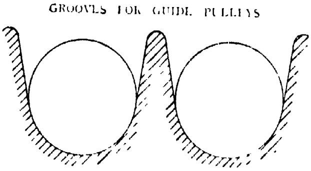


FIG. 41.

Fig. 40 shows the trailing span or curve of a rope when the slack side is on the top or the bottom, the dotted lines showing the case with slack side at the bottom, and the full lines with slack on top.

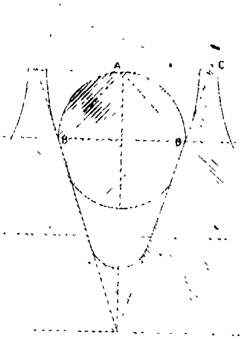


FIG. 42.

Fig. 41 shows the shape of the guide pulleys, and Fig. 42 the grooves of the driving and driven pulleys.

Q. 1899. What is the best way of driving (*a*) carding engines, (*b*) speed frames, (*c*) mules, (*d*) ring frames? You may select any counts, stating the speed at which you would run the driving pulleys on the various machines. What do you consider the best speeds for the line shafts, and the best way of transmitting the power from the engine?

A. The speeds of line shafts for all processes up to the mule and ring frame may be, say, about 260 revolutions per minute or less. The high speeds of spindle required for the mule and ring frame should have a higher speed of line shaft, say about 350.

It is good practice to drive a carding engine cylinder directly from the line shaft by an open belt, giving about 180 revolutions per minute to the cylinder.

As regards the pulley shafts of speed frames, it is the best practice to drive them directly from the line shaft by a half-crossed belt. Sometimes gallows pulley driving is used for these machines, and is more powerful than the half-crossed belt, but is liable to dirty the cotton and the frame, and is more trouble to put on. The speed of the pulley shaft or driving shaft may be put down at about 240 to 260 for the slubber, 270 to 300 for the intermediate, and 300 to 350 per minute for the roving frame.

As regards the mules, the general method is to have a counter shaft driven from the line shaft, and to drive the rim shaft by down belts from the counter shaft. The rim shaft speed may be put down at 600 to 900. In some cases of fine mules the counter shaft is not used, but the older system of direct driving from line shaft to rim shaft is in vogue. Mr Moorhouse, the inventor of duplex driving for mules, has recently invented a system of driving which is a sort of compromise between the old direct driving and counter shaft driving. A description is given on pages 80 to 86 of this volume.

In the case of ring frames the tin roller may make about 650 revolutions per minute. There are three systems more or less in vogue: (1) half-crossed belt, (2) direct driving by open belt, (3) gallows pulley driving. Because of the high spindle speed required, it is probably best to have gallows pulley driving. Main driving is discussed separately, in the previous answer.

Driving of Ring Frame.

There are really only two principal methods of driving ring frames in more or less extensive use, *viz.*, the half-crossed belt method and gallows pulley method.

The first-named is the neater of the two, and does not give as much trouble when a belt breaks, and is not as likely to dirty the rovings and the various parts of the frame.

It is the author's own experience, however, that the gallows pulley driving is on the whole the most satisfactory for ring spinning and ring doubling frames. The spindles run at a high rate of speed, and therefore a large ring frame requires a considerable amount of power to drive it. At the same time the half-crossed belt does not bite fully on the fast and loose pulleys of the frame, being held off to some extent by the necessarily large top driving drums of the line shaft. So far as the experience and observations of the present writer go, these objections often result in the half-crossed belts giving serious trouble by frequent breakages and by slipping if not kept very tight. On the whole, therefore, the author must give it as his opinion that gallows pulley driving is the more satisfactory method of the two, at any rate with anything like large frames and high speeds.

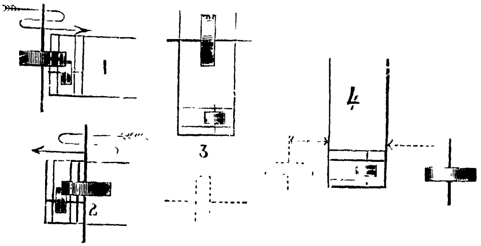


Fig. 12 (*a*).

Direct driving, double driving, rope driving and rim pulley driving are all in use to a comparatively limited extent.

It will be understood that with gallows pulley driving the line shaft is some distance from the end of the frame, and a much longer belt is thus obtained. At the same time guide pulleys have to be used, and are so disposed as to give a good full grip of the belt on the pulleys.

The tin rollers are now usually made in short lengths, coupled with strong shafts, and often made to run in Mohler self-adjusting and self-lubricating bearings, with cast-iron working on cast-iron.

An idea of the methods of driving a ring frame will be gathered from Fig 12 (*a*)

1 and 2. Direct driving by half-twisted strap.

3. Gallows pulley driving.

4. Direct driving by open strap.

To determine hand of the frame, face the gearing end, looking lengthwise of frame, and note if the pulleys are to be placed on right or left hand side.

LIGHTING.

Q. 1900. What should be the principle on which a spinning mill should be lighted? Where is it necessary to have the light in the various stages, and what arrangement would you advise to give the best effect by day and night respectively?

A. It is necessary for the best results to have ample light in a spinning mill, and the mill should be so constructed as to give the maximum amount of daylight, consistent with a building of sufficient strength. Good work often depends largely upon good lighting, whether by natural or artificial means.

The size of spinning mills renders it difficult to get proper lighting by natural means. If convenient a north light should be taken advantage of as far as practicable. In new mills it has become a common practice to attach a shed to the ground floor for the double purpose of providing sufficient space to hold all the card-room machinery on one floor and, at the same time, of admitting sufficient daylight to compensate for the obstruction caused by the engine-house, boiler-house and blowing-room. The ceilings, etc., should be constructed so as not to interfere with the light or to throw shadows. In the case of mules and frames it is better to admit the light at the ends than behind the creels.

As regards artificial lighting, gas is still perhaps the most extensively adopted, although electric lighting has been adopted in many mills and offers considerable advantages.

In the case of mules and frames it is the practice to have the gas or electric lights running the length of the machines a convenient distance between a pair. There is a space of several yards—often too much space—between each light, and the lights are usually suspended at a convenient distance above the operatives' heads, but not too high to be easily reached. Amongst the cards and in the blowing-room it is often considered that a less amount of light is required, as the ordinary work is scarcely so fine as in the spinning-room.

HUMIDIFYING.

Q. 1898. What are the chief advantages of humidifying the air in a spinning-room? Is it advisable to do it in the card-room? Give reasons for your answer in each case.

A. It is well known that a warm, humid atmosphere is the best possible one for the purposes of spinning cotton yarn. As regards the warmth, this has long been easily enough attained by arrangements of steam pipes, and of late wrought-iron pipes of small diameter, and heated with high pressure steam, have almost entirely displaced the cast-iron pipes of large diameter, heated with high pressure steam as formerly employed. Although there are differences of opinion as to the proper temperature of a room there has been no difficulty in getting the degree of heat required, and while some are satisfied at 75° F., some fine spinners will stop at nothing short of 100 F.

The humidifying of a room has been a more difficult matter, and even now it is a very moot question among practical spinners as to how far artificial humidifying is a success. The chief advantages in a spinning-room are that the cotton will work better, and having more elasticity will spin better and give better yarn. This is especially prominent on dry, hot days, or on days in which dry east winds prevail or even frosty weather when combined with a proper amount of heating. In the card-room there is less need of humid atmosphere, and furthermore there is great danger of rusting the card teeth of the carding engines or the needles of the comber when the latter are employed. The present tendency with humidifying apparatus is to apply appparatus which can ventilate, heat and humidify simultaneously, or any individual function may be performed. Sometimes, however, the want of humidity is felt more severely at the comber than anywhere else.

A humid atmosphere absorbs and destroys the effects of the electricity created by the friction of the belts and various working parts of the machines. Electricity makes the fibres curl and become intractable by creating mutual repulsion amongst them.

HUMIDITY.

There can be no doubt that the best condition of atmosphere for cotton growing, cotton spinning and cotton weaving is a warm, moist one, these two conditions appearing to be essential in order to get the best results out of the cotton fibre in practically all stages of its cultivation and manufacture. As regards heat in cotton spinning from 70° to 90° F. may be fixed as most usual, although these limits are often exceeded.

From 48 to 53 per cent. appear to be the best conditions of relative humidity for a spinning mill It must be understood that relative humidity is the thing to be considered, and that it equals the ratio of the absolute humidity to the maximum humidity.

Humidity, of course, implies moisture or dampness, and in many cases it is considered that the amount of moisture which appears best for the cotton fibre is injurious to the health of the operatives and to the bright metal parts of the machinery.

The above given best relative humidities have been fixed after repeated experiments by experts as being the best for spinning mills, and considering both cotton fibre, machinery and operatives.

It must be understood that the greater the heat of a room the greater the amount of absolute humidity required in order to reach the same amount of relative humidity. Heat alone is not sufficient for good spinning, and experience has long since demonstrated that dry, hot summer days are liable to give very bad work at the various stages, owing to the parching effect of the heat on the fibre and the fibres becoming very liable to electrical influence.

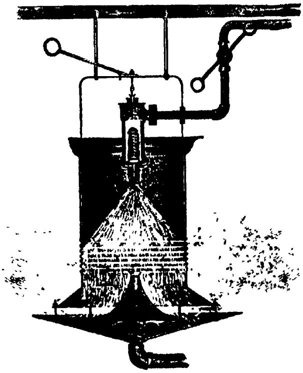


Fig. 43.

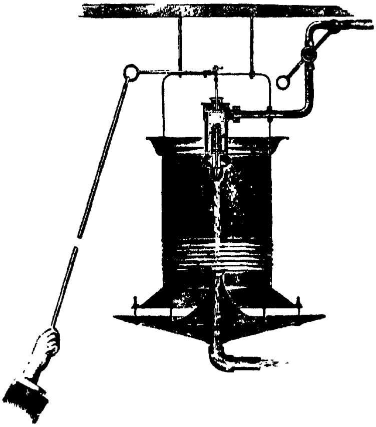


Fig. 44.

HUMIDIFIERS.

So fully have the benefits arising from a humid atmosphere been recognised during recent years that various methods of moistening the atmosphere by specially constructed apparatus have come strongly to the front On most days of the year, however, the atmosphere of the spinning districts of Lancashire is so naturally humid that only a limited number of these humidifiers have been installed in our spinning mills.

In some cases water is forced by means of special pumps at a strong pressure through small apertures, and the water impinging against a fixed surface is broken up into an infinite number of fine particles so as to humidify the surrounding atmosphere. Such an arrangement is shown herewith in Figs. 43 and 44.

In other cases air is blown over or through water and the moistened air is injected into the rooms.

In still other cases water is placed in open troughs and allowed to evaporate, this evaporation in some instances being assisted by running steam pipes through the water.

Well-known makers of such apparatus are Messrs. Hall & Kay of Ashton-on-Lyne, Messrs. Howarth of Farnworth and the Drosophore Company of Manchester.

Figs. 43 and 44 illustrate the apparatus as made by the latter firm. These appliances are arranged at intervals in a room, say one to each pair of mules. Fig. 43 shows the apparatus at work, while Fig. 44 shows an arrangement for cleaning it and washing it out at intervals.

THE HYGROMETER.

In the mills it is now becoming a somewhat extensive practice to adopt what is called a hygrometer, or hygrophant. By means of this instrument the amount of relative humidity present in a room can be readily ascertained--that is to say if it be a good standardised instrument, constructed on sound principles, and placed in a proper position. Some hygrometers have had the wet bulb and dry bulb too close together, and have not been placed in a sufficiently central position. It may be explained that an instrument of this kind consists of two thermometers, one of which as usual registers the temperature of the room, while the other has its bulb more or less covered with a thin piece of muslin cloth attached to a strand of material which is connected to a small well of water. The moisture absorbed by the strand causes the wet bulb to indicate a less amount of heat than the dry bulb, because the evaporation of the water from the muslin abstracts heat from the wet bulb and reduces its reading. There is supplied with the hygrometer a printed table, so that by comparing the difference between the readings of the wet and dry bulbs with the table the relative humidity can be ascertained quickly.

The principle of action of the instrument is this: When the surrounding atmosphere is very humid little moisture is absorbed from the muslin of the wet bulb, and therefore little heat is abstracted from the bulb, as the one follows the other. A dry atmosphere absorbs more moisture from the muslin, and reduces the temperature of the wet bulb more. It follows that the nearer the readings of the dry and wet bulbs are to being equal the more humid must be the atmosphere surrounding the hygrophant.

FIRE PREVENTION AND EXTINCTION.

Q. 1896. Name the chief forms of fire preventing appliances used in modern spinning mills.

A. These may be summarised as follows: Water buckets, hand fire extinguishers, fire engines, stand pipes and sprinklers.

One of the readiest and oldest fire extinguishing appliances used in cotton mills consists of buckets kept filled with water. These are extremely serviceable in cases of small fires, and have been of the utmost utility in numberless instances. One of the worst defects of this system is that the buckets soon become empty, owing to the evaporation of the water and other causes. Periodical refilling of the buckets is therefore necessary, and this is often neglected. Times without number mill officials have got into little difficulties with the insurance people owing to empty buckets. Often spinners are so busy piecing up, doffing, etc., in these days of quick speeds, at the time for refilling that they are almost compelled either to miss refilling the buckets or stop the mules up for a short time. An American firm got over the difficulty by adopting the somewhat expensive method of hanging each bucket upon a hook fitted with a piece of spring steel in such a manner that when the weight of water in the bucket got below a certain amount a bell was rung in the manager's office, thus directing his attention to the nearly empty bucket. Even with the most modern fire extinguishing apparatus, in the opinion of the author, the old water bucket ought to be maintained.

There are several devices by which a kind of hand fire-engine or fire-queen is used. Being filled with water a kind of bottle filled with chemicals of a somewhat explosive character is so placed inside the bucket that it can be readily broken when needed. The chemicals then act upon the water in such a manner as to force the latter strongly out of the nozzle or pipe to a considerable distance. In this way it can be directed to the exact spot where the fire may be with great accuracy. These fire-queens, however, appear often to be neglected, and therefore soon become worthless, and, on the whole, their use seems to be rapidly diminishing.

Formerly it was a very common plan to have attached to a mill of any size a ponderous fire-engine. This was the precursor of the modern steam fire-engine. A good number of men operated the machine, and pumped water out of the reservoirs into the engine, and thence upon the fire. Few of these engines are now maintained in good working order at cotton mills. In most mills, whether new or old, upright water pipes are laid in the corners of the staircases from top to bottom. On each landing there is a nipple, to which can be screwed a hosepipe, the latter being then carried to the scene of action in case of fire. The pipes may be either coupled to a steam fire-pump or to an efficient supply of water, such as the town's mains or the reservoir.

SPRINKLERS.

The most modern, and by far the most distinctive and efficient application for the extinguishing of fires, is found in the employment of sprinkler heads. There are several leading types of these, but in all cases a good number of pipes are arranged above the machinery and the operatives' heads, and are kept filled with water from a large tank situated at a good height, or else from the town's mains or other efficient supply. The sprinkler heads should be arranged about ten feet apart, so that the sprays or discharge from adjoining heads will easily touch each other. All specially dangerous places—such as wheel boxes, rope races, etc.—should have extra sprinkler heads. Rules are now given by the insurance companies with regard to certain proportions and dimensions to be maintained in putting up sprinkler installations. For instance, the base of the tank should not be less than fifteen feet above the highest sprinkler head, so that the water can be ejected with sufficient force out of the highest sprinkler head—say, a pressure of not less than seven pounds at this point. Tables are also given regarding the capacity of the tank for holding water. For instance, when the greatest number of sprinkler heads on any one floor exceeds 200, the minimum capacity of the tank must be 7,500 gallons. A rather striking part of every sprinkler installation is the application of an alarm gong outside the building, and arranged so that if the pressure of water falls by any means the gong is sounded. If, for instance, a fire were to occur in the night time, not only would the heat melt the fusible part of the contiguous sprinkler heads, and so allow the water to issue with considerable force upon the exact location of the fire, but also the gong would give the alarm to the surrounding neighbourhood. The Grinnell, the Witter, the Titan and others are well-known types of sprinklers, chiefly differing in the special construction of the sprinkler head itself. In all sprinkler arrangements there must be two sources of water supply, one of which is practically unlimited. Indicators are fixed by which the pressure of water in the pipes and the depth of water in the tank can be easily gauged. Sprinklers are receiving very extended application throughout this country, and the insurance companies make a very considerable reduction in the premium when sprinklers are adopted. It has become a generally recognised standard to fix the fusing point of the sprinklers at 155° F., although it may be, say, 160° F. before the sprinklers really go off.

The foregoing answer is much more exhaustive than would be practicable at an examination.

The Grinnell sprinkler head is shown in Figs. 45, 45 (*a*) and 45 (*b*). Fig. 45 is a view of the sprinkler closed ; Fig. 45 (*a*) represents the sprinkler open for the discharge of water. A solid half-inch stream impinging upon the deflector spreads in a profuse shower in all directions.

The peculiar and distinctive feature of this sprinkler is that the valve is seated on a flexible diaphragm, and is held in a

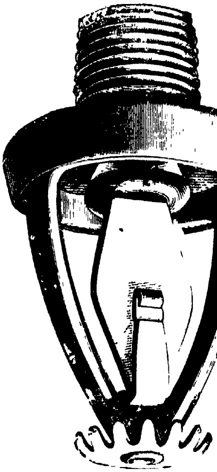


FIG. 45.

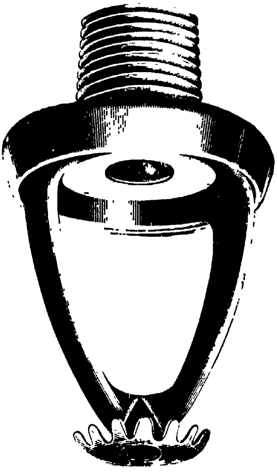


FIG. 45 (*a*).

manner calculated to relieve the low-fusing solder of much of the strain.

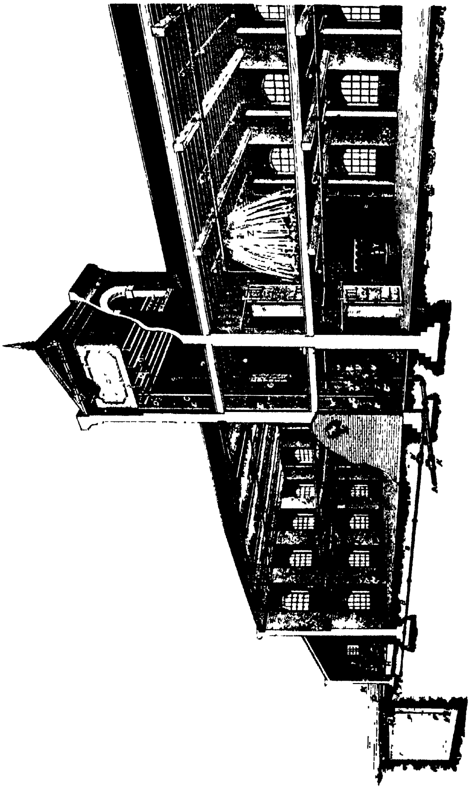


Fig. 45 (b).

Fig. 45 (b) is a longitudinal section of a factory showing arrangement of piping, valves and water supplies for the Grinnell automatic sprinkler.

REFERENCES.

A Main Supply from Town's Main.
A′ Back Pressure Valve.
B Main Supply from Fire Pump.
B′ Back pressure Valve.
C Down Pipe from Tank.
C′ Back pressure Valve.
D Tank.
D′ Tank Drain and Overflow.
E Tank Feed.
E′ Stop Cock on Tank Feed.
F Ball Tap.
G Indicator Board.
H Quadruple Acting Fire Pump.
K Stop Valve on Pump Connections.
M Foot Valve
N Strainer
P Pump Suction Piping
R Alarm Valve.
S Main Installation Stop Valve.
T Combined Drain Valve and Test Cock.
U Pressure Gauges.
V Alarm Gong
V′ Pipe to Gong.
W Armoured Fire-Proof Doors.
Y Simplex Chemical Extincteur
Z Sprinkler in Action

CHAPTER VIII.

ARRANGEMENT OF MACHINERY AND MILL PLANNING.

Q. 1898. Upon what principles would you proceed to place the machinery in a mill if you desired to work it economically, especially in respect of the avoidance of handling the material?

A. The best practice is to put all the scutching and card-room machinery on the ground floor and the spinning-rooms above. This frequently necessitates the building of an extra shed to the ground floor, in order to accommodate a sufficient amount of card-room machinery. To take as an example, a modern mill arranged to spin fine numbers, the ground plan is somewhat as follows:—

The scutching-room and the boiler-house are at one end of the mill, being, of course, well separated from each other, and having the engine-house and the rope race between them and the large card-room and shed. From the scutching-room there is easy access round the corner of the wall containing the rope race into the card-room. Over the scutching-room is the cotton-room, where the cotton is put down the feed trunks of the openers. The laps from the openers are passed through the scutchers, which are arranged conveniently for handling the cotton, and the laps from the scutchers are conveyed to the cards. The sliver lap machines and the combers are arranged next to the cards, and the drawframes conveniently to the combers. From the drawframes the cotton is passed on to the slubbers, which are close by the intermediate frames, and the roving frames following closely on and being quite adjacent. The bobbins from the roving frames are quickly conveyed on bogeys running upon slips to a hoist, and taken up to the spinning-rooms, where again there are slips for the bogeys to run upon down to the proper pair of mules.

In a mill not using combers the cards might extend all down one long side of the ground floor, and the roving frames down the opposite long side of the same floor, between the two may be the drawframes, slubbers and intermediates, set lengthways, or end to end with the roving frames

Q. 1896. How are the machines used in a blowing-room arranged to obtain the most economical results in modern mills? Give sketch plan. Give briefly your reasons for preferring any special opening machine for any particular kind of cotton.

A. Take a mill of about 80,000 spindles spinning, say, average 42's counts of American cotton. The usual plan is to have for these conditions two opener and lap machines combined, four intermediate and four finisher scutchers. The openers are often fed by means of exhaust trunks from the room above. Each opener is placed behind two scutchers, and may be placed more particularly behind either the inside or outside one of each pair of scutchers, just as may be deemed most convenient. The four finisher scutchers are placed immediately in front of and in a line with the intermediate scutchers. These positions facilitate the transference of cotton from one machine to another with a minimum expenditure of labour, besides making the arrangement to appear symmetrical. It would be an easy thing to give a plan view indicating the positions of the various machines as the question requires.

The Crighton type of opener is the most popular for medium counts of yarn as made by one or other of the various machinists Most of the latter—whilst having some special form of beater of their own—also make large numbers of the Crighton. One of its chief merits is that it exercises a kind of discriminatory action upon the cotton, operating more upon heavy or tangled masses of cotton than upon lighter and more open portions. This is largely due to the fact that the cotton has to be lifted upwards by the action of an air current induced by a powerful fan. Messrs. Dobson & Barlow make an opener which is specially designed for the better classes of cotton, as it is considered that the action of the Crighton is too rough for these cottons. The machine under notice is designed to open the cotton in a very gentle manner. It contains two pairs of feed rollers and one pedal roller, which are adjustable. The draft in these rollers can be regulated somewhat so as to assist in opening the cotton before reaching the beater. The machine contains two beaters—the first containing six blades, to which are riveted hardened conical steel teeth, and the second has three special steel blades, with case-hardened striking edges.

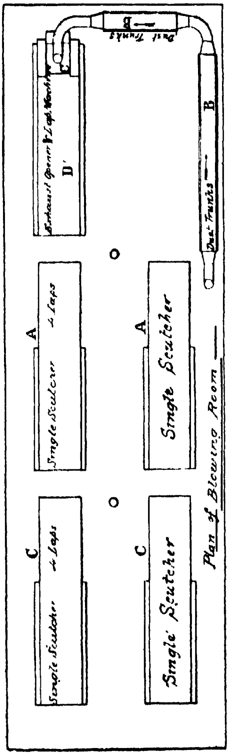


FIG. 46.

In another and later machine for good cottons made by the same firm there is only one large cylinder made either with up or down stroke as may be required. The beater or cylinder is of the porcupine character, fitted with many knives.

Fig. 46 shows the plan of a blowing-room fitted with one exhaust opener and four scutchers. The cotton enters through the trunk, B, and passes through the opener, D. This opener keeps the two breaker scutchers at A going. Each breaker at A keeps a finisher going at C. Such an arrangement would serve for, say, a mill of 45,000 spindle spinning average about 45's single roving American cotton.

Q. In what storey of the mill is the card-room now usually placed, and why? What are the best positions with relation to it for the blow-room and mixing-room, having regard to the reduction of labour and fire risk?

A. It is now the usual practice to place all the card-room machinery on the ground floor for two or three reasons:—

(1) Steady running of the machinery with a minimum amount of vibration is secured. (2) The handling of the cotton in its passage from one process to another is much facilitated. (3) When all the card-room machinery is on one floor the supervision of the machines by the carders, overlookers and managers is rendered easier.

This placing of all the card-room machinery on the ground floor constitutes one of the most important modifications that have been made during recent years in the planning out and arrangement of cotton spinning mills.

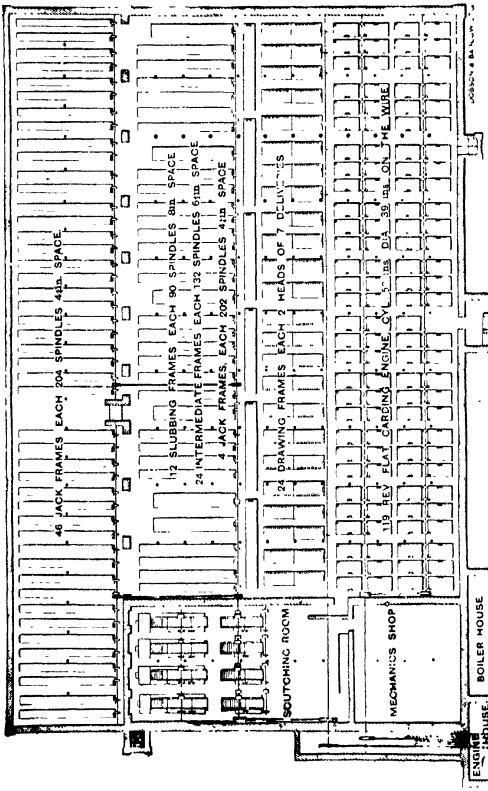
The blowing-room should be always separated from the card-room on account of the great danger of fire in the openers and scutchers, and also because of the dirtier and dustier nature of the opening processes and the heavy driving required for the machinery.

The blow-room should always be fitted with iron doors which can be readily closed in case of fire.

Apart from these considerations it is advisable to have the blow-room as convenient to the card-room as possible, on account of the laps having to be carried from the scutchers to the cards.

The two rooms are best when on the same floor, although this advantage does not always exist. There should be a passage between the two rooms of, say, a minimum length of

9 or 10 feet, fitted with an iron door at each end. In modern mills often the rope race is interposed between the blow-room and the card-room.


46 JACK FRAMES, EACH 204 SPINDLES 4½in. SPACE
12 SLUBBING FRAMES EACH 90 SPINDLES 8in SPACE
24 INTERMEDIATE FRAMES EACH 132 SPINDLES 6½in SPACE
4 JACK FRAMES, EACH 202 SPINDLES 4½in SPACE
24 DRAWING FRAMES EACH 2 HEADS OF 7 DELIVERIES
119 REV FLAT CARDING ENGINE CYL 50 ins DIA 39 ins ON THE WIRE
SCUTCHING ROOM
MECHANICS SHOP
BOILER HOUSE
ENGINE HOUSE
DOBSON & BARLOW

PLAN OF THE CARD ROOM FOR A BOLTON MILL OF 80 648 SPINDLES.

FIG. 16 (*a*).

The mixing-room may be placed over the blow-room, so that the cotton can be passed through holes in the floor down to the openers, but the holes should be fitted with

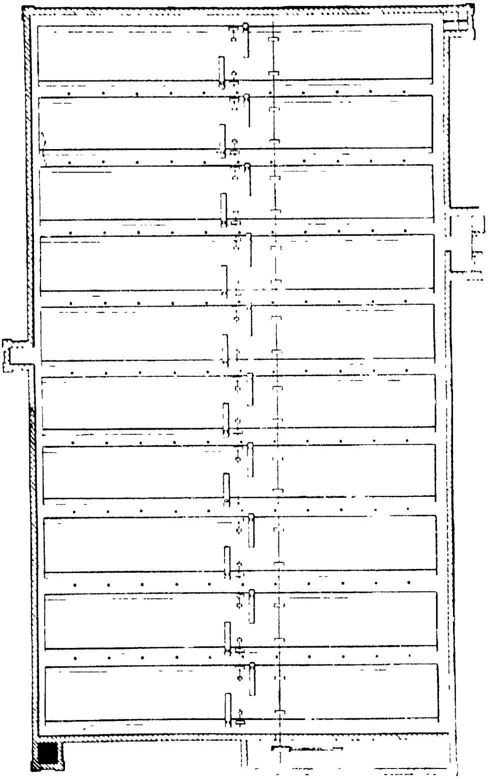


Fig. 46 (b).—4th Spinning Room of Bolton Mill (Spinning 40's Twist).

											Spindles.
1st	Room	contains	20	mules,	1,050	spindles	each,	1¾	in.	space	21,000
2nd	,,	,,	16	,,	1,058	,,	,,	1¾	,,	,,	16,928
3rd	,,	,,	20	,,	1,066	,,	,,	1¾	,,	,,	21,320
4th	,,	,,	20	,,	1,070	,,	,,	1¾	,,	,,	21,400
											80,648

iron doors for shutting in case of fire, and the floor should be in all cases fireproof.

A rather safe plan is to have the cotton fed in the mixing-room to long exhaust trunks, through which the cotton is forced by powerful fans forward to the openers.

Fig. 46 (*a*) shows the plan of a card-room fitted up by Messrs. Dobson & Barlow, while Fig. 46 (*b*) shows the fourth floor of the same mill, this room and others being filled with mules.

Q. 1899. You have to order the machinery for a mill to spin counts from 40's to 50's, say 40,000 lb. weight of twist and 10,000 lb. weight of weft on mules. The building is 100 feet wide, and you can allow for alleys five feet, and for gearing and ends of machines as follows: drawing frames (straight beams three heads), 7 ft. 6 in.; speed frames, 3 ft. each; mule, 5 ft. 3 in. The cards are made with cylinders 40 in. wide, 50 in. diameter. Say (*a*) at what speed would you run the various machines, beginning at the card to get the production; (*b*) how many cards you would use; (*c*) how many drawing frames, giving gauge, number of heads and deliveries; (*d*) number, lift and gauge of spindles in slubbing, intermediate and roving frames respectively; (*e*) number of spindles in each mule, giving gauge. What weight of finished scutcher lap would you require to feed the card to get the total weight of finished yarn named?

A. Some speeds might be taken at practically the same as given in answer to a previous question. Each card may be assumed to produce 800 lb. of sliver per week; each draw-frame delivery, 820 lb.; slubbing spindle, say, fifty hanks per week; each intermediate spindle, fifty hanks; each roving spindle, forty hanks. The doffer of the card may be taken at about fourteen revolutions per minute.

$$\frac{50,000}{800} = 62\tfrac{1}{2} \text{ cards,}$$

with two or three added for loss in waste.

$$\frac{50,000}{820}$$

say sixty finishing drawframe deliveries, with two or three added for waste. There would be three heads or passages, giving a total of the above deliveries multiplied by three. Gauge of spindles may be taken at slubbing, 8 inches between centres of adjoining spindles in front row; intermediate, 6¼ inches; roving, 5 inches; twist mules, 1⅜ inch; and weft mules, 1⅛ inch. Lifts may be taken at slubber, 10 inches; intermediate, 9 inches; and roving, 8 inches. The number of spindles in the bobbin and fly frames would be got by dividing the hanks per spindle into the total hanks required to be produced by the frames, and the spindles per frame would be divided out to suit the special conditions, and the same may be said of the mules.

Q. 1900. Give a scheme of drafts to produce (*a*) 20's hosiery yarn, (*b*) 50's weft, (*c*) 100's combed Sea Islands. You must state what weight of lap you begin with at the card.

A. For the 20's hosiery the card sliver might be taken, say, at ·15 hank sliver, and the weight of lap fed to the card at about fourteen ounces per yard. At the drawframe we might put six ends up together, and there would in all probability be a total draft of about six. The slubber might have a draft of five and produce a ¾-hank slubbing, although many people would only have a ⅝ slubbing for these counts even though it be for hosiery. Assuming a draft of about five at the intermediate and two ends up, we should then have a draft of about six at the rover with two ends up so as to produce a 5¾-hank roving. As hosiery yarn requires to be usually soft spun we are favouring the spinning by giving a comparatively fine hank rove for 20's, and using double roving at the spinning machine. We, therefore, get 20's with something like seven of a draft. The above hanks and counts are finer than would be for single roving. For 50's weft (Egyptian cotton), taking double roving at the mule, we may have a lap of 11½ or 12 ounces per yard, a draft of about 115 in the card, giving about a ·2 hank sliver, six ends up at the drawframe; slubber, making one hank slubbing with a draft of about 4·6; on intermediate, a draft of six with counts of almost three; on rover, a nine-hank roving with a draft of about 6·5; on mule, a draft of about eleven. 100's combed Sea Islands: We might start with a lap of about 9½ ounces per yard, and from the card produce about a ·28 hank sliver with a draft of, say, 135 to 140; drawframe, 6, 7 or 8 ends up, optionally, with draft in proportion; at slubber, a draft of 4·3, producing a one hank and having four passages of fly frames; intermediate, 4·5 draft with 2¼ hank; rover, about five draft and 5¼ hank, fine Jack draft of six and hank of sixteen; at mule, a draft of about 12 or 13. The comber might produce a sliver the same counts or a little coarser than card with total draft of about thirty and effective draft of about five.

Q. 1900. Suppose that you had a free hand in the erection of a mill spinning a wide range of counts, say from 20's to 50's, two-thirds of the production being from 26's to 32's, what kind of machines would you select, and how would you arrange as to lifts of bobbins and other details? You can assume any total output you like.

A. Since the bulk of our production has to be from 26's to 32's, with a smaller amount of yarn ranging down to counts 20's and up to counts 50's, it will be convenient to take a basis of, say, 30's average counts For these counts the following particulars would be suitable, taking a mill of, say, 42,000 spindles, producing 1 lb. per spindle per week, of 30's average counts.

One bale breaker, with four pairs of rollers and a draft of about thirty-five, would pull the requisite amount of cotton very nicely, and should be coupled up to properly disposed mixing lattices.

We might allow two openers, fitted with hopper feeds and large beaters, either of the Crighton or the cylindrical type, as either would do very well for this class of cotton. In many cases there would be three intermediate and three finisher scutchers for American cotton, but some people would now dispense with the intermediate scutchers. The finisher scutcher may make a lap of 13½ ounces per yard.

The cards would be of the revolving flat type, and would work well with a draft of 100, producing, say, 750 lb. of sliver per week per card. The hank sliver might be, say, ·160. It is not likely that the combing series of machines would be used. The drawframes might have a draft of six or less with six ends up, producing about 800 lb. per delivery. Three passages of fly frames. The lifts might be slubber, 10 inches; intermediate, 9 inches; rover, 7 inches. Whether the mill would be all rings, all mules, or a proportion of each, would depend upon circumstances, but any of the three would be possible. We might have a ¾ slubbing, a 1½ intermediate, and a 4-hank roving. These hanks are for single roving at the spinning machine.

Q. 1896. Assume that you were starting a mill for spinning one of the following counts: 26's ring twist, 36's twist and 40's weft, 60's twist or 80's weft. How would you arrange the drafts of the various machines, beginning with the carding engine, and stating the weight of finished lap?

A. We will select for our answer 36's twist and 40's weft as being the example, which will probably be familiar to a greater number of our readers than any of the others. We will start with a lap which weighs 14 oz. to the yard, and then for 36's we might have the following drafts: Card, 100; at each head of drawing, 6; slubber, 3·88; intermediate, 5·25, roving, 6·5; mule, 8.

A 14 oz. lap = ·00136 hank lap, as shown below:—

$$\frac{8\cdot3333}{14 \times 437\cdot5} = \cdot00136.$$

Then proof of drafts =

$$\frac{\cdot00136 \times 100 \times 6 \times 6 \times 6 \times 3\cdot88 \times 5\cdot25 \times 6\cdot5 \times 8}{6 \times 6 \times 6 \times 2 \times 2}$$

$$= \text{about } 36\text{'s}.$$

For the 40's weft we might maintain all the same dimensions, excepting that we have a 5·15 draft at the intermediate and a 4·5 draft at the slubbing frame.

Proof:—

$$\frac{\cdot00136 \times 100 \times 6 \times 6 \times 6 \times 4\cdot5 \times 5\cdot15 \times 6\cdot5 \times 8}{6 \times 6 \times 6 \times 2 \times 2}$$

$$= 40\text{'s}.$$

A better plan for getting the 40's weft than the foregoing would be to maintain the first-named dimensions as given for the 36's as far as the roving, and then put a little extra draft on the roving frame, and serve the weft mules with a little finer hank bobbin than the twist. In some cases it would be quite as useful and more economical to maintain all the conditions given for 36's up to the spinning-room, and to get the 40's weft by putting a little more draft than eight into the mules. In any case it must be distinctly understood that in actual practice none of the dimensions given are hard and fast rules, as we should seldom find two mills exactly alike in all particulars. Some men would put a less draft in the slubber because of the stuff being so soft and thick. Frequently the draft is changed somewhat at some of the machines to make the stuff thicker or thinner according to the wrapping. Often the drafts are changed in some of the machines in order to make them turn off a greater or less weight of cotton, as the case may be, and this has to be counteracted by altering the draft elsewhere in order to keep the finished counts at the same thing. Often a different weight of lap would be adopted than 14 oz. to the yard, and this would have to be counteracted in some of the machines by altering the draft. Some mills, for instance, would adopt a lap 12 oz., or, say, 12·75 oz. to the yard for the counts under discussion, which would equal respectively ·0016 hank lap and ·0015 hank lap. This with a draft of 100 in the card would give respectively ·16 hank sliver and ·15 hank sliver. In order to obtain the correct finished counts of yarn in either of these cases, one or more of the drafts in the subsequent machines would have to be made less than as given for the 14 oz. lap.

Q. 1901. What drafts would you use to spin (*a*) 24's ring frame twist from a ·15 hank sliver of Indian cotton, omitting the intermediate frame; (*b*) 40's weft from a ·16-hank sliver, good middling American; (*c*) 100's twist from a ·19-hank sliver, from Egyptian cotton, with and without a jack frame?

A. *For 24's Twist.*—

$$\frac{24}{\cdot 15} = 160 \text{ total draft without doubling.}$$

Allowing two ends up at the roving frame only, we get 160 × 2 = 320 total draft.

We may assume five draft at slubber and seven draft at roving frame.

Then—

$$\frac{320}{5 \times 7} = 9{\cdot}14 \text{ draft at ring frame.}$$

For 40's Weft.—

$$\frac{40}{\cdot 16} = 250 \text{ total draft without doubling.}$$

Assuming doubling at intermediate and roving frames and single at the mule, we get 250 × 2 × 2 = 1,000 total draft.

We will assume drafts as below :—

At the slubbing frame . . .	4·5
At the intermediate frame . .	5·5
At the roving frame . . .	6·5

$$\frac{1{,}000}{4{\cdot}5 \times 5{\cdot}5 \times 6{\cdot}5} = 6{\cdot}2 \text{ draft at mule ;}$$

or better results would be got from the following : —

At the slubbing frame . . .	4
At the intermediate frame . .	5
At the roving frame . . .	6

$$4 \times 5 \times 6 = 120,$$

and

$$\frac{1{,}000}{120} = 8{\cdot}3 \text{ draft at the mule.}$$

For the 100's *Twist without Jack Frame.*—

Assume at the slubbing frame . .	6
Assume at the intermediate frame .	7
Assume at the roving frame . .	8

Then— $6 \times 7 \times 8 = 336.$

Assuming double roving at the intermediate, the rove and the mule, we get—

$$\frac{100 \times 2 \times 2 \times 2}{19} = 4{,}210 \text{ total draft.}$$

Then—

$$\frac{4{,}210}{336} = 12{\cdot}5 \text{ draft at mule.}$$

For 100's *Twist with the Jack Frame.*—The total draft will be then 4,210 × 2 = 8,420. Let the drafts at the four fly frames be 4, 5, 6 and 7 respectively.

Then—

$$\frac{8{,}420}{4 \times 5 \times 6 \times 7} = 10 \text{ draft at mule.}$$

Q. 1901. Assume you have 35,000 ring spindles producing 14 oz. per week each of 40's yarn. What number of preparing machines would you want, at what speed would you run the spindles, and what production would you expect to get from each ?

A. Before we can proceed to ascertain the number of machines required it will be necessary to lay down certain particulars as a working basis. Such particulars are given in the table below, but it must be understood that in different mills very different particulars are sometimes worked upon.

TABLE.

Machine.	Counts.	Production.	Waste per cent.
Card . . .	·16	800 lb.	5
Drawframe delivery	·16	800 ,,	1
Slubber . . .	¾	50 hanks per spl.	¾
Intermediate . .	1½	48 ,, ,, ,,	½
Roving frame . .	5	40 ,, ,, ,,	½
Ring frame . .	40's from single roving		2

$$\frac{35{,}000 \times 14}{16} =$$

30,625 lb. of yarn produced from the mill.

$$\frac{30{,}625 \times 100}{98} =$$

31,250 lb. of cotton from roving frame.

From this point we will take the waste inclusive to the cards, although this is not a strictly correct method.—

$$\frac{31{,}250 \times 100}{97{\cdot}25} =$$

32,133 lb. of sliver from the card

$\frac{31{,}250}{40} = 781$ roving spindles.

It will be near enough for our purpose to assume the same production from the intermediates and slubbers as from the roving frames, and the same production from the drawings as from the cards:—

$\frac{31{,}250}{48} =$ intermediate spindles,

$\frac{31{,}250}{50} =$ slubber spindles,

$\frac{32{,}133}{800} = 40$ cards,

and the same number of finishing drawframe deliveries. We might say that for this quantity of yarn we should require—

1 bale-breaker,
1 opener,
2 finisher scutchers,
2 breaker scutchers.

As regards speeds of spindles we might say—

8,500 for the ring frame,
1,050 ,, ,, roving frame,
760 ,, ,, intermediate frame,
570 ,, ,, slubber frame.

Q. 1901. Describe and sketch the arrangement of spinning machines in a mill producing from 30's to 40's yarn two-thirds twist (*a*) on mules, (*b*) on ring frames. Say (1) the number of spindles and gauge of machines; (2) if any difference in the arrangement of the line shafts is necessary in the two cases; (3) if any variation would be needed in the number and size of the preparatory machines.

A. In the case of the spinning-room filled up with mules the latter might extend across a wide mill, and there is usually in such a case one line shaft extending over the mule creels, at right angles thereto, for the full length of the room. Such a line shaft should be placed several yards away from the nearest mule headstock, in order to give a sufficiently long top belt. This is shown clearly on page 189.

In the case of a room being filled up with ring frames, there might be two lines of ring frames in the width of the room, and in most cases there would be a line shaft to each line of frames. In some cases the line shafts are placed over the ends of the frames and half-crossed belts are used while in other cases the line shafts extend over the creels, and gallows pulley driving is adopted.

The gauge of spindle for the twist mules would be probably 1¾ inch, and for weft 1⅝ inch.

The space or gauge for the ring frame spindles might be 2¾ inch for twist and, say, 2¼ inch for weft. For these counts, 30's to 40's, we might take each ring spindle to equal, say, 1¼ mule spindles, and the number of preparatory machines would have to meet this difference.

Q 1898. Give briefly a scheme of drafts and speeds for the production of 20,000 lb. per week of 32's twist from middling Orleans cotton. State the weight of lap you would make at the finisher scutcher, the hank sliver at the card, and the allowance you would make for waste throughout from the finisher scutcher.

A. For the cotton specified a lap of 13 oz. per yard might be employed, and probably about this weight is very common in actual practice. The hank sliver at the card and the drawing frames might be, say, ·152 with a hank slubbing of ·625. The hank intermediate might be set at 1·5, while the hank roving for these numbers is more often 4 for single roving at the mule than any other counts. For double roving at the mule it would have to be finer, as indeed it sometimes is for single roving 32's, while a few firms have it a trifle coarser.

As regards waste it might be approximately allowed for at the rates of 1½ per cent. at the finisher scutcher, 5 per cent. at the card, ⅞ per cent. at the drawframes, and ½ per cent. at each of the fly frames, and a little more at the spinning machines.

As regards drafts for 32's yarn made for single roving 4 hank, as assumed, there would be 8 at the mule. At a roving frame fed with a 1·5 back bobbin the draft would be 5·3. At the intermediate frame fed from a ·625 back bobbin the draft would be 4·8. At the drawframe it might be taken that the draft would be approximately 6, or equal to the number of doublings. At the slubbing frame fed from a sliver of ·152 the draft would be about 4·05. At the card the draft would be somewhere about 100 under the conditions stated.

As regards speeds the cylinder of the card may be put at about 160 revolutions per minute and the doffer at 13. The speed of the spindles of the slubbing frame might be about 500 per minute, that of the intermediate frame 680 per minute, and the roving frame, say, 1,050 per minute. The spindles of the mule or ring frame might be about 9,000 revolutions per minute. The speed of the front rollers of the various machines would, of course, depend upon their diameters, and the amount of twist being put into the cotton at any particular machine. These speeds differ somewhat from those given on page 197, and it must be understood that such variations exist in actual practice.

Q. 1897. If you had charge of a mill containing 40,000 mule spindles spinning 36's yarn, and half of them were substituted by ring spindles, what changes would you make in the preparation machinery, and why?

A. It is very probable that the 20,000 ring spindles would turn off approximately about one-fifth part more weight of yarn than the 20,000 mule spindles for which they were substituted. This would increase the total production of the mill in 36's yarn something like as 8 is to 9, and would have to be met by a like increase in weight of rovings from the card-room. There are, of course, three principal ways in which this could be done. They are, first, by increasing the speed of the card-room machinery and allowing the counts at the various machines to remain untouched; secondly, by making the hank roving, hanks intermediate, hank slubbing, etc., coarser, and making a corresponding increase in the draft of the spinning machines, in order to get the 36's out finally; thirdly, by obtaining a sufficient amount of extra card-room machinery to meet the case.

As to which of these three we should put into practice, or whether we should meet the case with a blending of two of the three methods, or even all three, would depend upon local circumstances and the opinions of those in charge. As touching the first-named alterations, if our card-room machinery were already quite up to speed, common sense would teach as at once that our remedy would not be found there, but if, as might be the case, it was more or less under-speeded, we should naturally take advantage of that circumstance, and put the speed up. It would be an easy matter to speed most of the card-room machinery up by putting less pulleys on the main shafts of the various machines, although we should better avoid slippage of belts by making line shaft pulleys larger.

As regards making hank roving, etc., coarser, this would be contrary to what would be good practice in order to get good spinning and good yarn. On the ring frame for the same counts of yarn many practical men will have a little finer hank roving than on the mule, because on the latter machine we have the principles of "drag" or "gain" to aid the "draft," while these principles are practically absent in the ring frames.

The provision of more roving spindles, in the approximate proportion of as 8 is to 9, would be in most cases undoubtedly the best practice to follow, in order to meet the case in a properly balanced manner and to keep up the quality of the spinning and of the yarn produced. There would probably be room for extra frames by the ring spindles taking up less room than the same number of mule spindles, and it would be a matter for still further reflection as to what extent the machinery should be increased through which the cotton passes before reaching the roving frames.

CHAPTER IX.

WASTE AND WASTE SPINNING.

Q. 1898. You are assumed to be dealing with a mixing of low middling American and Dhollera cotton in the proportion of two to one. What proportion of waste would you expect to find (*a*) at the opener, (*b*) at the scutcher, (*c*) below the undercasings at the carding engine, and (*d*) as strippings?

A. It is probable that the opener would make about 4 to 5 per cent. of waste, very little indeed of which would be of much use to anyone. We might reckon the waste at the first scutcher at about 2 per cent., and that at the second scutcher at about 1¼ per cent. The total waste at an ordinary revolving flat carding engine is usually somewhere about 5 per cent., and it is probable that this total does not vary a great deal whether the card be using low, medium or good American cotton, or even Egyptian cotton. Furthermore, the percentage in some cases may be more for the better cottons than for the worst, or the opposite may hold good, according to the general conditions of the card and the manner in which the various parts are adjusted to each other. The author has personally known the waste to vary at the card between 1 and 7 per cent. Taking 5 per cent. as the basis for the descriptions of cotton under notice, it is probable that about 3·2 of this 5 would be due to the strips from the flats, cylinder and doffer, leaving about 1·8 to be due to the undercasings of the taker-in and cylinder and from below the doffer and lap and sliver waste.

Cylinder Breaking-up Machine.

Cop bottom and similar waste is often passed through a six-cylinder machine or else twice through a three-cylinder machine, such as shown in Fig. 46 (*c*).

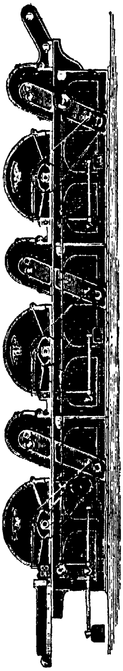


Fig. 46 (*c*).—Three-Cylinder Machine with Fans.

The single cylinder machine (Fig. 47) is also sometimes used.

It is usual also to make a lap on a scutcher about 18 inches wide with hopper feed as shown in Fig. 48.

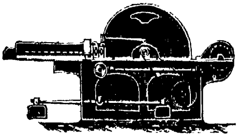


Fig. 47.—Single Cylinder Machine without Fan.

Q. 1897. Describe briefly the method of preparing and spinning waste yarns suitable for wefts and flannelettes.

A. The machines used in waste spinning properly so-called differ very considerably in character from those used in ordinary cotton spinning. They vary somewhat in style and arrangement, but a good modern arrangement may be taken as follows: First, cop bottom machine, or hard waste breaker, or Oldham willow, these differing in construction from one another, but in all cases being arranged to subject the cotton to considerable breaking up. Secondly, a scutcher may be used, differing somewhat from the ordinary type of scutcher as used for cotton spinning. Thirdly, a breaker roller card, which is more suitable for waste spinning than the revolving flat, as the latter tends to take too much waste out, and to give the fibres a disposition more approximating to the parallel than the roller card; neither of these properties being wanted in waste spinning. After the breaker card may be used the Derby doubler, in order to make a lap suitable for placing behind the finisher roller card, the latter being generally used in waste spinning. This card should be fitted with a condenser at the front, in order to wind the cotton into suitable form for the waste spinning mule or billey. This last-named machine differs from a spinning mule in having no drawing rollers, as it gives the slight attenuation necessary to the cotton by the principle of "ratching" or "jacking". The processes of waste spinning are distinguished from cotton spinning by the absence of drawing rollers in the former, the two chief objects of drawing rollers being unrequired, *viz.*, attenuation of material to a very fine degree, and making the fibres parallel, and also making the yarn very uniform. As much attention as possible should be bestowed upon the cotton in the earlier processes in order to secure an approximately even thread. Yarn spun in the manner indicated would suit flannelettes or the wefts of similar goods.

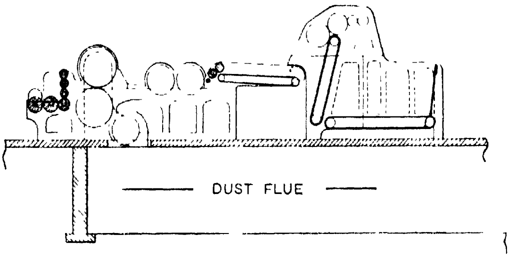


FIG. 18.

Q. 1897. What should be the weight of waste made per week in a scutching machine through which is passed 15,000 lb. of Orleans middling cotton, and in a revolving flat card producing 800 lb. of slivers from the same cotton? Does the character of the waste vary at different parts of either machine, and, if so, how? Give the percentage of waste made at each point.

A. The total waste made by the scutcher may be taken at approximately 1½ per cent., and for the card at approximately 5 per cent. These percentages would in the cases under discussion give the total waste of the scutcher at 225 lb, and that of the card at 40 lb., reckoning on the above total weights of 15,000 lb. and 800 lb. respectively. The waste of a breaker scutcher would be greater than that of a finisher, and might reach 2½ per cent. To be strictly accurate on the card the waste would be, say, 42 lb.

As regards the distribution and character of the waste, it may be said at once that it differs very materially in both respects at different parts of either machine. In the scutcher the greater portions of the waste and impurities are found below the beater bars. The very numerous and powerful blows of the beater have the effect of causing the comparatively heavy seed, leaf, shell, dirt, etc., with some proportion of fibre to fall through the grate bars; the first of which is frequently set some distance—say half an inch or so from the feed roller, in order to allow of the heavier impurities falling through. The droppings here are usually quite black looking, with leaf, shell, etc., as compared with those elsewhere.

In the cavity underneath the cage bars is found a much less proportion of droppings, and it is whiter, with shorter fibre than the preceding, and the leaf is smaller. The grate bars, however, for this cavity have been more subject to differences in shape than the beater grate bars, and at the present time we have them laid at right angles to the sides of the machine, or parallel thereto, or in a herring-bone style, just as the case may be. Crighton's employ a travelling lattice called the leaf extractor at this point, the same idea being lately adopted by another machinist.

From the insides of the cages, and more especially from the upright box ends of the cages, and out of the exit trunks is gathered at times a smaller proportion of very heavy black dirt, consisting largely of very short and broken fibres which have passed through the interstices of the cages, along with fine dust and sand, the latter being the weighting part of this waste.

At the card the great bulk of the waste is formed either below the licker-in or as strips from the flats or the cylinder and doffer. The licker-in and its mote knives and undercasings play practically the same part on the card as the beater plays upon a scutcher, and from beneath are taken out all the heavier impurities which have escaped the previous processes, such as seed, motes, leaf, etc. There should not be much short fibre or fly taken out at this point, and especially is this the case with modern metallic takers-in and the dish feed. The short fibre and fly are largely taken out by the flats, and, passing to the front of the card, are there stripped out by the stripping comb and stripping brush, and fall down upon the doffer cover. A fair amount of strippings are embedded in the teeth of the cylinder and doffer, and are at intervals removed by the stripping brush used by the strippers and grinders. A comparatively small percentage of waste is gathered from beneath the doffer and the cylinder, but nothing near as much as was the case before the very general adoption of improved undercasings.

Q. Specify the proportions of waste usually made in the different processes of a cotton spinning mill.

A. An approximately correct list would be somewhat as below:

Opener	say	4	per cent.
Breaker scutcher	,,	2	,,
Finisher scutcher	,,	1¼	,,
Card	,,	5	,,
Drawframes	,,	1	,,
Fly frames	,,	1¾	,,
Spinning	,,	2	,,
Total,		17	per cent.

With good clean cotton the total waste may come out as low as 14 per cent., while with dirty, wasty cottons the per cent. of waste is increased.

When combers are used the average loss per cent. in waste for the comber alone may be taken at about 17 per cent.

Q. In some mills the waste made in the different processes is brought back to the mixing to be worked over again. If too much is put into the mixing at once, what is the effect on the lap, as well as upon the yarn?

A. The addition of waste to a mixing tends strongly to give lap-licking, because of its soft character. In proportion to the amount of waste put in with the good cotton the yarn becomes weaker, more irregular and less compact, while the waste is very liable to again come out as waste at the various machines. The most common practice is to take bobbin waste back to the mixing, and a certain amount of this is often permissible, except in very good yarns.

With a large proportion of waste it is very difficult to keep "nep" and "slubs" out.

Q. Name and shortly describe the various kinds of waste made in Oldham spinning mills.

A. (*a*) From the openers and scutchers: droppings from below the beater bars and cage bars, and dust and dirt from inside the cages and dust flues. Little of this can be used again.

(*b*) From the cards: strippings from the flats, cylinder and doffer; strippings from rollers and clearers, and from the ends of these rollers, if such are used; licker-in fly and fly from beneath the doffer and cylinder; sliver waste and lap ends.

(*c*) From the frames: sliver waste and bobbin waste, top and bottom clearer waste, waste from roller laps and broken rovings.

(*d*) Spinning waste, crow waste, top clearer waste, waste from roller laps, bad ends, waste from picking saddles and roller ends, bobbin waste, piecing-up waste.

In addition to the foregoing we might specify the following: cleaning waste or oily waste, sweepings up, old banding.

Q. 1900. Describe the methods of preparing the various kinds of waste for re-spinning. How are they prepared for carding, how treated, and how delivered by the card? Is it possible to draw waste yarns? If so, to what extent, and where is it effected?

A. Broadly speaking, there are two principal classes of waste used in waste spinning: (1) Soft waste, which includes all waste made before the cotton has received the final twist at the mule or ring frame. (2) Hard waste, which comprises all waste made after the cotton has been twisted at the final spinning process. The various kinds of waste are subdivided according to cleanliness, etc. For some purposes it is better that the waste should be of a greasy character, and to impart this to the cotton there is occasionally used a "soaper," which is an appliance fitted to the opener. In the blowing-room various kinds of openers are more or less in use containing anything from one cylinder, or beater, up to six or more. For very soft waste a one-cylinder machine is often used, while for hard waste the six-cylinder machine is a favourite. After the opener a wide scutcher is usually employed to make a lap for the card. These machines are shown in previous sketches.

In waste spinning it is customary to double card the cotton and to use the roller and clearer card. To secure uniformity often two laps are fed together behind the breaker card.

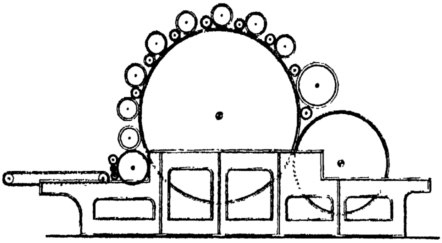


FIG. 49.

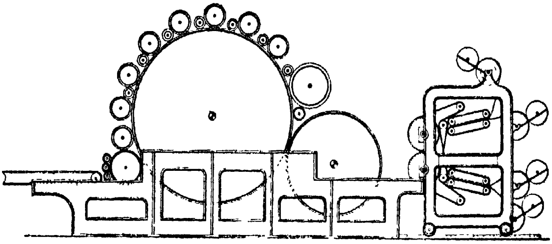


FIG. 50.

Sometimes the cotton is transferred from the breaker to the finisher by the Scotch or cross-feed arrangement, while in other cases the slivers from the breaker are converted into narrow laps on the Derby doubler, and two of these are placed end to end behind the finisher card.

It is sought to deliver the fibres finally in a crossed and intermingled condition—as distinct from the parallel arrangement—hence the use of the roller and clearer card.

The cotton is taken from the finisher card by a condenser, which divides the doffer web into a number of narrow strips, which are rubbed into strands and wound side by side on the long condenser bobbin. A condenser arrangement is shown in fig. 54.

The number of divisions or strands varies greatly according to the counts to be spun.

It is not often that drawing rollers are used in waste spinning, the usual practice being to take the long condenser bobbins and place them behind the waste spinning mule, in which only one pair of rollers are used. The only "draft," therefore, is between the spindle points and these rollers, and it seldom exceeds more than about 40 to 50 inches pulled into about 70 inches.

Diagrammatic views of the breaker and finisher waste cards as made by Hetherington are shown in Figs. 49 and 50.

Q. 1899. Assume that you are dealing with a mill producing 30,000 lb. weight of twist yarn per week from American cotton, what quantity of waste would you expect to get? How much cotton would you need? Distinguish between the various kinds of waste, and say how you would dispose of each. Does the amount of waste vary from year to year?

A. The total loss over all might be, say, 16 or 17 per cent. Some of this would be invisible loss, and some would be visible, in the shape of fly, droppings, rovings, etc., In many cases students and others work this calculation as follows: Taking the total loss to equal 17 per cent., then to get 30,000 lb. weight of yarn warm from the spindles, we should want 30,000 lb. of cotton plus

$$\frac{30{,}000 \times 17}{100} = 5{,}100 \text{ lb.}$$

According to this we should therefore require 35,100 lb. of raw cotton. The more correct method is as follows:-

$$\frac{30{,}000 \times 100}{83} = 36144{\cdot}5 \text{ lb.}$$

of raw cotton required. By this latter method the waste is allowed for on the added quantity. Waste from the blowing-room and sweepings up are of very little use except for making into manure, or flocks, or candlewick yarn. The strips and fly from the card and the clearer waste may be used up in waste spinning and mixed with Bengals in the production of coarse quilting, weft, etc. Roving waste is often used up again in the spinning mill, and comber waste also is often used for the ordinary processes of cotton spinning.

Q. 1899. In carding waste yarns how is the material fed? State fully the different methods pursued, what position the fibres occupy relatively to the card teeth, and what advantages are claimed for each method.

A. In some cases the material may be fed in loose state behind the breaker card, while in others two laps from the scutcher may be placed behind the breaker. To feed the finisher card there are mainly two methods. (1) The slivers from the breakers are made into laps for the finisher by the Derby doubler. (2) In the second case the Scotch or cross feed takes the cotton in the form of a ribbon from the breaker and spreads across the back of the finisher as it were in layers so as to form a continuous sheet.

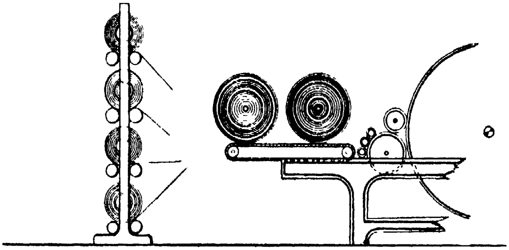


Fig. 51.

The fibres are crossed and mixed a great deal in relation to the card teeth, as it is not desired to make the fibres parallel. The Scotch or cross feed probably presents the fibres in a more crossed manner to the finisher card teeth than does the sliver lap machine. The condenser is an apparatus placed at the delivery end of the finisher card, by which the web or fleece is divided into individual strands or ends, which are then wound on the condenser bobbins ready for the creel of the mule.

Various methods of feeding are shown diagrammatically in Figs. 51, 52 and 53.

Fig. 51, at left hand, shows Bank's feed; Fig. 52, at the left hand, shows the lap drum; and Fig. 53 shows the Scotch or cross feed method of conveying the cotton from breaker to finisher.

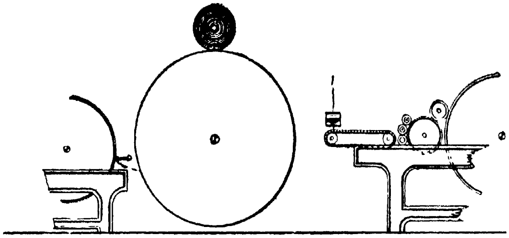


FIG. 52.

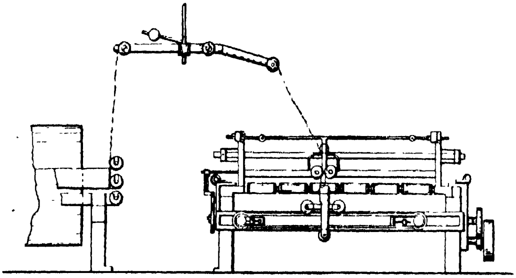


FIG. 53.

Q. 1900. For what purposes are waste yarns employed? For what kinds of fabrics are they most useful, and why?

A. The worst waste spun yarns are used for a large assortment of coarse purposes, such as candlewick, lampwick and cleaning cloths. It is probable that the better classes are of the greatest service in the production of cheap goods which are intended to be raised, and are required to be soft to the feel, such as flannelette and cotton blankets. A good deal of waste spun yarn is used for the weft of plain and fancy quiltings and goods of that character as to material used.

Q. 1898. Describe generally the mode of spinning the slubbings produced on a condenser carding engine from waste yarn. How are they drawn?

A. It must be remembered in considering this question that in this case none of the machines used would contain drawing rollers, so that the pertinence of the examiner's query - How are the slivers drawn?—will in this connection

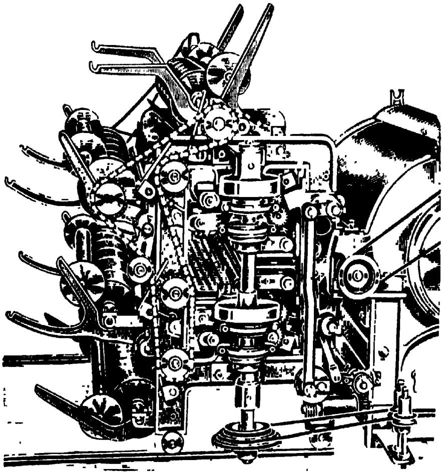


FIG. 51.

be made very clear. On a condenser carding engine the fleece from the doffer is divided up into a number of parts, say, for instance, in this case about 22. Each part is rubbed or condensed and wound upon a long condenser bobbin nearly the full width of the card. Fig. 54 shows the delivery end of a finisher waste card fitted with Bolette's steel tape condenser. The condenser bobbin thus formed is taken directly to the specially formed creel of the "Billey," or waste spinning mule. Such machines as the drawframes and the bobbin and fly frames are omited altogether. In the waste spinning mule, or "Billey," there are drawing rollers, but simply a pair of large diameter rollers through which the slubbings pass, very much after the style of the rollers of a ring doubling frame, with the important difference that the top rollers are much longer.

The term "mule" is to some extent a misnomer when applied to the Billey, since a "spinning mule," properly so called, ought to possess both drawing rollers and the principles of "ratch" and "gain". In the Billey the comparatively soft slubbings being passed through the rollers and attached to the twisting spindles, the carriage and rollers may both move for something more than one half of the usual stretch of 72 inches. Then the rollers may stop while the carriages finish the stretch and the requisite amount of twist is put in the yarn. It is quite obvious that only the coarsest numbers can be spun in this manner, owing to the limited amount of drawing power possessed by the machines used. A soft, thick yarn is produced, admirably suited for some descriptions of goods.

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